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Accident Reduction

The claims for disablement compensation are augmented yearly, and those which are contested usually centre around safe working places, safety of access to work and industrial diseases. The first has been complicated in recent years by the fact that if one of the workpeople is responsible for an accident to another, the employer is liable to pay compensation. Safety in access to working places is dealt with in an article which appears elsewhere in this issue, and from it, it is obvious, that the greatest diligence is necessary on the part of management to reduce these hazards to a minimum. In one case, a firm was asked for compensation, because during the rush from—not to—work a man was knocked down and received injuries. The question of industrial diseases, is now receiving greater attention, due to the extra hazard following upon the increasing tempo of manufacturing through mechanization. The reduction of dust is being energetically undertaken by the foundry industry and good progress has been made with grinding machines, portable tools and knock-outs. Problems related to general atmospheric conditions are as difficult of solution as the creation of smokeless areas in large cities. Atmospheric conditions affect factories in a manner analogous to a depression over Iceland influencing weather conditions in London.

It is obvious that a series of problems has to be solved by the foundry industry in order that accidents and diseases may be reduced. A newish worry here is dermatitis, a complaint to which some people are prone and others immune. Cleanliness, using suitable washing agents—not paraffin and the like—will keep this to a minimum, but those especially prone to such diseases should be transferred to other work. There are three established means for minimizing accidents and we place them in the following order of importance. Primarily, somehow or other, there must be inculcated into the minds of every person in the factory an enthusiasm for safety conditions. Secondly, there must be developed a high sense of good housekeeping and finally there is the formation of a safety-first organization to propagate the first two precepts.

It is usually accepted that the provision of modern washing and bathing facilities is expenditure which will remain for ever on the debit side of the balance sheet, yet it may be that in the long run such outlay will show some return through the beneficial effects of personal cleanliness, in just the same way as the first-aid departments have undoubtedly minimized the chances of small accidents becoming of major importance. Though the humanitarian aspect of accident and health hazard prevention must obviously remain the cardinal endeavour in the conduct of a foundry, yet the serious costs consequent upon accidents are such that they constitute a high charge upon the revenues of the industry. From both these viewpoints, no efforts should be spared to make the shops and their machinery "foolproof" and so to animate those who work in them with a mental alertness that they are fully alive as to the risks attendant upon industrial operations.

Correspondence

FUEL EFFICIENCY

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—In your JOURNAL for May 6, you give an extract from *Fuel Efficiency News* for April, detailing methods of coke economy in foundries, suggested by the Council of Ironfoundry Associations, and it is most surprising to see no mention of the use of recuperative hot-blast cupola for this purpose. Your leader, in the issue of the same date, on the recent rise in coke prices, also does not specifically mention this.

Results in this country have shown that the use of recuperative hot blast at 500 deg. C. will enable coke economies of up to 35 per cent. to be made, without reduction of tapping temperature, or alteration in iron composition. On the Continent, where coke prices are as high, and in many cases higher than in Great Britain, there must be now between 100 and 150 hot-blast cupolas working on the recuperative system, as against only 10 in Great Britain. It is not surprising, therefore, that British light and heavy industries are finding it increasingly difficult to meet Continental competition, particularly from Germany, if they allow themselves to be so backward in technical development, in such a basic industry as iron founding.

It would appear that the habits, due to possessing abundant, and at one time cheap, coals in Great Britain (one of our greatest national assets) die too slowly, if no counter-steps are taken to meet the changing conditions.—Yours, etc.

J. MILES

Granite House,
Cannon Street, London, E.C.4
May 17, 1954

STRUCTURE OF GRAPHITE SPHERULITES

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—We have read with interest the comments of Dr. Wittmoser and also his paper in the Technical and Trade Supplement of *Geisserei*, October, 1953, vol. 12, pp. 571-85, and appreciate his general agreement with our overall evaluation of the structure of graphite spherulites.

A mistake seems inadvertently to have crept in the correspondence of Dr. Wittmoser. In the third paragraph it is stated that "the newly exposed nodule No. (4) in which sectioning has passed through the centre point carries a core in both Figs. 1 and 2." However, in Fig. 1, nodule No. (4) is not shown. The use of the term "different degrees of polishing" by Dr. Wittmoser may give an impression that it refers to the fineness or perfection of polish, whereas we believe Dr. Wittmoser actually implies "different sections." For instance, in paragraph (3) it is stated: "Figs. 1 and 2 show the same micro-section after different degrees of grinding and polishing." Obviously, Figs. 1 and 2 could not represent the micro-structure of the same section, but micro-structure of the same set of nodules across different sections. It does not seem logical to us to argue that the "top" part of the nodule could possibly be structurally in any way different from its "bottom" counterpart. The "top" and "bottom" parts are strictly relative terms—what is "top" becomes "bottom" when micro-examination is conducted from its opposite side.

As stated in our paper, we observed the white spots to occur in both the hemispheres, *i.e.*, the so-called "upper" and "bottom" parts of the nodule. However, the number of sections exhibiting the white spot in the hemisphere of nodule which is sectioned later (bottom part) may be less than in the hemisphere sectioned first (upper part), since, as we have observed in our experiments, the chances of the residual graphite being polished out of its embedment are increased, when much less than half of the nodule is embedded in the matrix.

Since, according to Dr. Wittmoser, the white spot is confined only to the "top part" and the relief structure to the "bottom part," one could not expect to see a section depicting both the "white spot" and the "relief structure." However, in the original paper of Dr. Wittmoser, there are two photographs (Figs. 5-*b* and one of the nodules in Fig. 16) which clearly show both these structural features contradicting the present remarks of Dr. Wittmoser. Such a structure containing both the "white spot" and the "radial structure," though uncommon, was explained in our original paper, as limited to such zones where the "structureless pattern" tended to merge with the relief structure, *viz.*, the radial pattern.

If the findings of Dr. Wittmoser were accepted, that the "central white spot" was confined to the "top part" of the nodule and the relief structure to its bottom counterpart, we could then expect, in a random micro-section, the number of nodules depicting "central white spot" to be about the same as those showing the "relief" or "radial structure." However, it is our observation that in a random section this is hardly so; in fact, the proportion of nodules with a typical radial structure was much smaller than the 50:50 basis. Furthermore, Weld *et al** have stated that over 60 per cent. of the nodules exhibit the "central white spot." Therefore, it will be logical to expect the occurrence of white spots in both the hemispheres and these are clearly depicted in Fig. 15 of our paper.—Yours, etc.,

M. N. PARTHASARATHI.
B. R. NIJHAWAN.

National Metallurgical Laboratory,
Jamshedpur.
May 10, 1954.

* Weld, *et al*, *Journal of Metals*, 1952, 738.

Birmingham University Plans

Birmingham University Department of Engineering has received an endowment from the Churchill Machine Tool Company, Limited, of Manchester, to carry out a research project on grinding. The object of the research is to establish the principles affecting the performances of a grinding machine and the surface finish produced on a component. This is the first of many researches which it is hoped to carry out in co-operation with industry in the laboratories of the new mechanical engineering building to be opened in July.

One of the laboratories in the new building is a machines laboratory for research into production processes. It is to carry out projects on the following lines: (1) research into automatic transfer equipment; (2) study of the factors involved in the production of precision surfaces and (3) projects on the development of precision parts, such as concentricity. There is to be a metrology laboratory equipped with £10,000-worth of precision measuring equipment, most of which is being obtained as a result of an endowment made by the Coventry Gauge and Tool Company, Limited. The production planning laboratory is to work on three-dimensional $\frac{3}{8}$ in. per ft. scale-models of factories and machines.

Running and Feeding Methods for Grey-iron Castings*

By P. A. Russell, B.Sc., F.I.M.

The subject is confined to the production of castings of the type where soundness is the first consideration. In designing a runner system for this type of casting it is necessary to decide at the outset whether the casting can be made sound by control of solidification by runner positioning, or whether definite feeding is necessary. These are two distinct methods, and should never be confused.† Following the Paper an extensive discussion is reported.

Wherever possible, the method of obtaining casting soundness by directional solidification should be used. The best example is the use of the distributed runner, where the uneven cooling of the casting is counterbalanced by the runner system, even to the extent of keeping the downgate away from the small boss on the rim. Another application is for flywheels, clutch-plates, gear blanks and similar parts, where the casting will freeze uniformly providing that the runner does not form a hot spot. A 5-cwt. flywheel in 15-ton-tensile iron has been run by this method without any feeders.

In distinct contrast is the method of running a casting *via* a feeder; there is the strainer-core method, which the Author first saw used in the malleable industry, and the spinner runner. Perhaps the runner which has created the most interest in grey-iron foundries in recent years is the "Connor" or "block" runner, first illustrated and named in a Paper given, at the Author's instigation, by one of his foremen, Mr. Measures. The idea was had from Mr. Connor, a London foundryman, but the system cannot claim to be his exclusive invention, as it has been in use, particularly in Yorkshire, for many years. The Connor runner/feeder has been found most useful in irons with phosphorus above 0.5 per cent., and, now that most of the irons made in the Author's foundry have phosphorus below 0.2 per cent., this type of runner is not so successful. This is not everybody's experience, however, for instance, Mr. L. W. Bolton uses it extensively on low-phosphorus irons. The block runner has the great advantage of requiring practically no fettling, and the Author has used this lip-running principle very successfully when there has been no need to do any feeding. The running system also occupies very little moulding box space, and makes for economical production. A combination of the "Connor" and the "distributed" runner is in use for a heavy gear-blank casting. This is called the continuous lip feeder.

Other Feeding Methods

Turning now to the type of castings requiring even more feeding than can be given by the above methods, the Author has, naturally, tried some of the various forms of runner devised for steel and non-ferrous castings. They seem, in some ways, more difficult to apply to grey iron, particularly phosphoric iron. The "skin" of such an iron is too weak to apply the "atmospheric" principle and the longer total-solidification time makes the exothermic-sleeve principle more difficult to apply. The Author has found particular value in the use of exothermic powder on the top of feeders and rather less value in exothermic sleeves and knock-off cores. The cost of exothermic sleeves is rather frightening to the producer of grey-iron castings, and in the only case which is being regularly applied in the Author's foundry, the cost, taking great care to use exothermic compound in only the part of the riser where it is effective, works out at 2s. per cwt. of casting.

Personal interest in runners, as a practical foundryman producing jobbing castings, has in recent years gone rather away from the "feeding" aspect of runners and risers to the realization of the importance of the runner system as a whole in the production of good castings—or—putting it another way, in the prevention of scrap. Few moulders or foremen seem to realize the importance of the runner, which the customer never sees. Yet every drop of metal that forms the casting has to pass through the runner system which is often subjected to far more erosive action than one would be prepared to allow the main mould to endure. And yet runners, particularly down-gates, are seldom formed in facing sand and, in drysand moulds are extremely difficult to protect with blacking. Downgates about 2-ft. long for one job, for instance, have to pass between them a ton of metal. The consequent erosion must mean that the sand, probably entrained in metal —and called "slag" by the foundry—enters the casting. When examining American jobbing foundry practice in the United States last year, the Author was impressed by the precautions taken to prevent this trouble. These usually took the form of very-carefully-made oil-sand cores to form the down-gates of all large castings. These were carried as a constant stock, to be drawn on by the moulders, and were cut to length to suit the job.

Also, the Author believes that the preconceived ideas on runners of many foundrymen have been upset by seeing the various films now available on the flow of metals, particularly the excellent one produced by the Institute's Technical Committee, and which no doubt the Birmingham branch had seen.

* Extract from a Paper presented to the Birmingham branch of the Institution of British Foundrymen.

† The Author also referred the members to a Paper on this subject he presented to the London branch of the Institute (printed in the JOURNAL, June 11, 1953) and several illustrations from that Paper were exhibited.

It has upset personal ideas on the "distributed runner" already referred to, and the Author urged upon foundrymen the desirability of observing runner effects by means of cutting and shaping the top part of a mould—though this was not as effective as the slow-motion-photography methods employed by the TS.35 sub-committee.

The I.B.F. Technical Council have another sub-committee working on runners, and it was clear that one of the most urgent problems of the day is to obtain the data necessary to put the running of castings on a logical basis. This is a section of the foundry industry where "rule-of-thumb" methods still apply, and no two foundries seem to have the same ideas on how to run a particular casting. Surely this is a problem that the Institute can help to solve?

DISCUSSION

Vote of Thanks

MR. SHEEHAN, in proposing the vote of thanks to Mr. Russell, said that he had timed Mr. Russell's lecture and in exactly twenty minutes Mr. Russell had given sufficient information to keep members in discussion for a great deal of time, both at the meeting and thereafter. Mr. Sheehan said that he understood that the Connor riser had been given the light of day in a paper in the United States of America by a Lt. Connor, of the Naval Dockyard. Whether this was so or not, he was sure of one thing, and that was that every foundryman by the name of Connor took credit for the riser so named!

The paper given by Mr. Russell was well prepared and very well presented and illustrated, and very many varieties of runners and feeder systems had been mentioned, but what Mr. Russell had pinpointed were the fundamentals. When particular types were tried for the first time, they were not necessarily going to produce correct castings, but combinations obtained by the various systems were worth trying.

MR. HALL, who seconded, said that it was perhaps pertinent that he, as a newly-appointed chairman of a new sub-committee appointed to investigate the yield of castings, was particularly interested to hear Mr. Russell say that there was some advantage in exothermic feeding, but he was also interested to find that Mr. Russell thought the expense was not justified because, as he had said, the melting costs of grey iron were not excessive. That he would accept, but he would not agree that the carrying about of the material cost very little, and therefore he did not think that his sub-committee would accept the statement that exothermic material necessarily cost too much.

Size Relationships

MR. BAILEY asked whether Mr. Russell had any fixed view on the relationship of the cross-sectional area of the ingates, the runner bar, and the downgates.

MR. RUSSELL said that, in his view, the ratios were fixed but flexible. On the whole, he said, if the ingate was a unit area, the crossbar should be 1½ units, but what was more difficult to decide was the size of the downgates. If it was said that the downgate should have an area of 1½ units, then it must not be overlooked that the downgate was vertical.

MR. CLARKE confirmed this and said that the downgate, being vertical, influenced the velocity to a great degree and, as this increased, so the section of the downgate might decrease. Regarding ingates and runner bars, he felt that when an attempt was being made to trap slag, it should be stopped back. If increased velocity was causing turbulence, then it was better to go the other way. With regard to the Connor type of feeder, Mr. Clarke said that in a series of tests he had carried out with this, only in the middle range of compositions of cast irons did he obtain any reliable results.

MR. DYBALL asked whether Mr. Russell had had experience of firebrick sleeves to line the downgate from the top to bottom.

MR. RUSSELL said that he had used firebrick sleeves, with excellent results. He said that when he had visited the United States of America on a tour of jobbing foundries, he had been very impressed with the care taken on downgates, and he had seen core-sand sleeves used, which were very carefully made. In one foundry he had visited there, two men were employed in making downgates in one corebox. The corebox was open on both faces and the core was rammed on both sides. If ramming was carried on from the top only, the sand would not withstand the heavy wash of metal. He had also been interested to find that these men were specially remunerated, so important was this work considered.

Cylinder Casting

MR. TWIGGER said that illustrations shown by Mr. Russell showed some remarkable examples of edge-running methods, but the castings were of no very great depth, and of fairly considerable diameter. Had Mr. Russell any experience of something in quite the opposite direction, for instance, a cylinder which was longer in relation to its outside diameter? In this respect, Mr. Twigger said his firm had obtained optimum results by bottom and top pouring, although this was not completely successful. Could any general principles be applied to running tall castings of small diameter?

MR. RUSSELL agreed with Mr. Twigger that the best method of pouring this type of casting would be from the top and bottom.

MR. ASTON said that when he went from steel-founding to ironfounding, he had naturally tried exothermic feeding for iron, and he would like to say that if a rather moist and red sand were used in the area immediately around the feeder head, a fair amount of success could be achieved.

Connor Runner

MR. FRANCIS referred to the Connor runners with the narrow slot, and said that unless there were very accurate box pins for positioning, he could foresee trouble. He asked whether special instructions were printed on the job card in that case.

MR. RUSSELL said that reliance was placed on

the accuracy of the pin and with worn pins there was a danger that the width of the aperture might vary.

MR. SHOTTON said he would like to ask about the Connor runner, as in thinking about the principle of it, he was somewhat concerned about the design of the runner. Mr. Russell, he said, had mentioned that the width should not exceed more than $\frac{1}{16}$ in., but the length of the slot was not mentioned, though, presumably, the rate of pouring was important. Could any information be given about pouring speeds?

MR. RUSSELL replied that pouring with a Connor runner would approach the speed of a normal runner but, if anything, it was better to run slightly slower rather than faster.

MR. SHEEHAN said an advantage of the Connor runner was that by feeding slower there was natural solidification occurring in the casting and some shrinkage would take place during the pouring period; this gave a very hot feeder head and that was an important factor in the success of the system.

MR. WEAVER said he would like confirmation that most of the moulds illustrated were dry-sand moulds.

MR. RUSSELL said that all those using the Connor runner were green-sand moulds.

MR. TAFT said, regarding green-sand moulds, that he had run four very difficult castings, to be machined all over, and had had 100 per cent. success with the Connor-runner system. He asked why Mr. Russell had tended to discontinue with the Connor system of running, as he himself had found them equally successful on high-duty irons, although trouble had been experienced until it was realized that the size of the runner was so critical. Was it because of changing to high-duty iron that Mr. Russell was tending to reject the Connor system.

MR. RUSSELL said actually he had been very disappointed that his firm had not obtained the success expected, but in meeting the American demand for free-machining irons they had had disappointing results and found an unfed patch in the castings. This he could not explain. Another point was that their foundry was composed of several sections, one section making irons from 20 to 24 tons in tensile, and in this section no success was made of the Connor system. Mr. Russell said that the bulk of the illustrations shown were made with synthetic-sand moulds.

Progressive Solidification

MR. FRANCIS said that the principle of the Connor runner was in line with progressive or directional solidification and that was the secret of success, because the metal was preheated and ran through hot, and eventually became the feeder. If these castings were knocked-out before they lost their colour, it could be seen that the feeder was as hot as the rest of the casting.

MR. TAFT said he was still puzzled, as in his opinion Mr. Russell should be getting more progressive solidification, even with the lower-phosphorus material.

MR. HIRD asked whether the height of the block had any influence, as if the height was increased, the risk of a sinking in the casting was surely reduced.

MR. RUSSELL said that this might very well be true.

MR. TAFT said that for one casting in their foundry they were using a very deep Connor runner, about $3\frac{1}{2}$ in., and they got a tremendous amount of sink in this particular casting.

MR. FRANCIS at this point had to bring the discussion to a close because of time, and once again thanked Mr. Russell for his lecture and his very able handling of the questions.

B.I.R. Congress in Amsterdam

From May 12 to 14, the *Bureau International de la Récupération* (B.I.R.) held its annual congress and general meeting in Amsterdam and participants were supplied with a booklet (printed wholly on rag paper) outlining the activities over the previous 12 months. As would be expected, since the Bureau covers all sorts of scrap from bones to borings, the findings as related to iron and steel and non-ferrous scrap are couched in very general terms. However, when it is realized that over 80 per cent. of all iron and steel scrap used has to be processed in some way—ranging from sorting to briquetting—the useful work of the Bureau in arranging some international denominators for these processes (as concerns prices, extraction processes, freedom of movement, and the like) can well be appreciated.

The PRESIDENT (Mr. Nyberle), assisted by Mr. Doisy, gave a general account of what was mentioned in the report about the organization of the B.I.R. and what it had accomplished since its formation. The chairmen of the various sections then gave summaries concerning the results obtained in their departments. Preparations are being made to attain uniform classification of the different sorts and qualities of waste materials so as to facilitate trade between the member-countries. Although the import of waste materials is free, in most countries export embargoes still exist for scrap iron, steel and non-ferrous metals. To attempt the freeing of trade in these articles, the assistance of O.E.E.C. is needed, and therefore the B.I.R. considers it a good augury that their organization is the first non-governmental one that is acknowledged by O.E.E.C. governments. Industries often hesitate to free the export of such materials because they want to be sure that sufficient amounts shall be available at any moment to keep their home industries in running condition.

The activities of the Coal and Steel Community have a notable influence on the trade of waste materials. The High Authority, having liberated the prices of iron and steel scrap, now has made the participation to the compensation fund obligatory for everybody instead of for member-countries only.

Amongst those who attended the Congress were guests from Iceland and Norway as observers, their countries not being members yet. Two associations from West Germany not yet participating applied for membership during the Congress, and they are to be accepted three months hence.

The banquet on the Friday morning was attended by some 200 people, including many ladies of the participants and some official guests representing the municipality of Amsterdam, the Minister of Economic Affairs and industry.

Notes from the Branches

Australia (Victoria)

At the April meeting of the Australian branch (Victoria) of the Institute of British Foundrymen, a Paper, "Australian Methods of Producing Special Pipes," was given by Mr. G. J. Benson. At the meeting on May 19 there is to be held the fourth round-table conference of the branch on foundry techniques. For this conference, the topic is to be "Foundry Inspection."

The current programme of the branch, which has now been published, includes such Papers as "Core-blowing," by J. Burfoot; "Casting of Magnesium and its Alloys," by Dr. F. A. Fox (at a joint meeting with the Australian Institute of Metals) and "Noise and its Control in Industry," by Dr. W. R. Lippert (joint meeting with the Institution of Engineers). Among the works visits arranged is one on September 15 to International Harvester Company at Geelong. The annual convention of the branch is to be held from November 10 to 12, with the annual dinner to close the proceedings.

Bristol and West of England

The meeting of the Bristol and West of England branch of the Institute of British Foundrymen held on the morning of March 20, was a very instructive one, when members heard a paper given by Mr. G. B. Partridge, which dealt with current light-alloy practice. Mr. Partridge traced the development of light alloys and dealt at some length with the more recent magnesium-base alloys. The advances made by the use of the new alloying agents zirconium, cerium and thorium were indicated by the author, who had brought along a representative selection of castings made from alloys of the type dealt with.

The necessity for scrupulous cleanliness in the foundry was emphasized, as was the careful attention to sand preparation and its utilization for all light-alloy practice. It was suggested that a rectangular sprue would often help to reduce turbulence in pouring, and that running techniques applicable to magnesium alloys could sometimes be usefully adapted for work with the aluminium-base alloys.

Replying to questions, Mr. Partridge made the following observations:—When dealing with alloys containing zirconium utmost cleanliness is essential, both as regards materials charged and the state of the melting pot itself. When producing magnesium-base alloys, the use of coarse-grain sands for cores is advantageous, and it is advisable to use sands of good permeability. The chilling qualities of natural sands can often be used to advantage. For gas scavenging of aluminium alloys, it was considered that chlorine was more effective than nitrogen.

Exeter Meeting

At the April meeting, the branch president, Mr. L. Buckley, presented a Paper "Modern Trends in Foundry Practice" at The Queen's Hotel, Exeter, when a large party of members and friends from Camborne, Cornwall, joined with the Bristol and Exeter members. Prefacing his talk with references to the many developments in foundry practice in recent years, Mr. Buckley then dealt in detail with the advances made in shell moulding, illustrating his remarks with samples of moulds and castings produced by this process. Many members were surprised at the excellent finish obtained on the castings exhibited, while the accuracy to which castings could be produced was impressive.

Replying to questions, Mr. Buckley stated that the penetration of bronze alloys in shell moulds could be very pronounced, and it was the lecturer's experience that even after 3,000/4,000 heating cycles, no measurable distortion was shown by the patternplates employed. Questioned as to the possibilities of collapsing of the shells, Mr. Buckley stated that the percentage of such failures was virtually negligible. In proposing a vote of thanks to Mr. Buckley, Mr. H. E. Holladay said that a practical paper of the type presented was greatly appreciated by the Exeter members, and the members were grateful to Mr. Buckley for having prepared so interesting an account during his term of office as branch president. Mr. C. C. Evans seconded the vote of thanks. After the lecture, the members and friends had a very enjoyable tea, the arrangements for which had been made by Mr. W. S. Kingdon.

Annual Meeting

The annual general meeting was held at the Grand Hotel, Bristol, on Saturday, April 24, Mr. L. Buckley branch president, being in the chair. In presenting his annual report, Mr. G. W. Brown, the branch honorary secretary, said that the branch had maintained its numerical strength during the past year and that great enthusiasm and support had been shown for the two works visits made during the session. An interesting lecture programme has been given during the winter months, and while attendance numbers had varied, all who had come along would agree on the high standard of papers presented. Announcing that Mr. D. Potts, a branch member, had been awarded the British Foundry Medal and Prize for 1954, the secretary said that the branch had every reason to be proud of its members, this being the second successive year in which a member had won this honour, Mr. D. F. B. Tedds having been the recipient in 1953.

In thanking members for their support during the year's activities, the secretary said he would like to add a special word of thanks to the members of the dinner and entertainments committees who had arranged the social evening on the opening day of the session, and the annual dinner, which was attended by the (national) president and Mrs. Longden, Mr. T. Makemson, Mr. and Mrs. MacKinlay and Mr. and Mrs. Wall of the Wales and Monmouth branch.

Finally, in thanking the retiring branch president for his help and guidance in branch affairs during his term of office, the secretary said he was certain that all members regretted that Mr. Buckley was leaving the area, but hoped that he would attend future meetings of the branch whenever possible. Mr. Tedds, the branch representative on the General Council, and Mr. Brown, representative on the Technical Council, then gave their reports, reviewing the work that had been done during the previous year.

The election of officers for the coming year then took place. These were: As *president*, Mr. H. V. Heath, as *senior vice-president*, Mr. D. A. Richards, as *junior vice-president*, Mr. D. P. Williams. Mr. D. F. B. Tedds and Mr. H. Balme were elected as representatives to the General Council, while Mr. G. W. Brown was re-elected branch honorary secretary.

General discussion had indicated that the works visits had proved very popular, and several members expressed the view that such visits might well become a feature of future recruiting activities, for considerable interest had been shown by friends and others engaged in the industry. Some of the visitors on these excursions had now joined the branch. The meeting concluded with the showing of the film entitled "Modern Malleable" which members found of great interest.

Nodular Cast Iron*

Present Position and Future Prospects as an Engineering Material, with Special Reference to Suitability for Crankshafts

By S. B. Bailey, M.Sc. (Eng.), M.I.Mech.E.

(*Continued from page* 584)

COSTS AND COMPARISONS

Selling Prices of Castings and Forgings

The costs so far quoted in this Paper have been the costs of producing treated metal in the ladle at the foundry, ready for pouring. To recapitulate, they are (per ton):—

Ordinary grey iron	£16 0s.
Nodular iron melted in acid cupolas and made by the magnesium/nickel process	£28 5s.
Nodular iron melted in basic cupolas and made by the magnesium/nickel process	£22 12s.
Nodular iron melted in basic cupolas and produced by direct addition of magnesium, followed by cerium treatment	£17 8s.

A comparative figure for carbon steel is about £19 per ton.

The selling prices of finished castings are greater than these by the cost of patternmaking, producing moulds and cores, innoculating, pouring, fettling, and heat-treating (where necessary), plus profit margins and overhead costs. Typical (1952) selling prices per ton for some of the ferrous castings were:—

Grey-iron castings to B.S. 1452 (British Standards Institution 1948)	£45-£100
Blackheart-malleable-iron castings for the motor industry	£80-£160
Carbon-steel castings	£60-£400

The sum of as much as £200 per ton was being asked for nodular-iron castings for the motor and agricultural-implement industries in 1952, though at this price the market was naturally somewhat limited: its very existence may have been encouraged by the long delays in delivery which were then being experienced with steel forging and castings. In the United States, nodular-iron castings are being sold at a price which is about 20 per cent. higher than that of high-grade grey-iron castings: a similar price differential in the United Kingdom would give them a selling price of £60-£120 per ton, depending on size and complexity.

The relation between size, complexity, and price per ton for typical difficult alloy-steel forgings (Diesel-engine crankshafts) is shown in Fig. 14, which has been derived from a price control schedule of the Ministry of Supply (1953). Typical figures for six-throw crankshafts are:—

	Ruling section.	
	4 in.	12 in.
In carbon steel	£99	£91
In 2½ per cent. nickel steel	£124	£117

and for fairly simple forgings (solid marine propeller shafts:—

	Ruling section.	
	6 in.	12 in.
In carbon steel	£52	£44
In 2½ per cent. nickel steel	£77	£69

It must be remembered that the figures given above do not make any allowance for the fact that there is usually much less machining to be done on a casting than on a forging: Templeton (1946) has quoted figures from which it may be concluded that the machining man/hours on six-throw cast-iron crankshafts lying within the above size range may be only from 30 to 55 per cent. of those required with forged shafts. The times saved varied from 40 to 100 man/hours on shafts having a finished weight of between 330 and 660 lb.; the value of this machine-shop time would be considerable. Furthermore, the rough weight of the forging might be anything from 20 to 400 per cent. greater than the rough weight of the casting depending on size and design, and this would obviously be reflected in the finished cost. Any comparison of the relative costs of forged and cast crankshafts must be a specific comparison for a particular shaft. Everest (1951) has quoted figures of £175, £75, and £48, for the finished-machined cost of a particular 600 lb. Diesel-engine crankshaft as press-forged, drop-forged, and cast. The forged shafts were of 1 per cent. nickel steel, and the cast shaft of acicular iron: the latter material is a nickel/molybdenum alloy cast-iron, having flake graphite and acicular ferrite, which is very strong but has practically no ductility.

Nodular Iron *v.* Other Ferrous Metals

It is evident that, as regards static strength and

*Abstracted from a Paper presented at a general meeting of the Institution of Mechanical Engineers in London, arranged in conjunction with the automobile division and the applied mechanics group. The Author is on the staff of Intelligence Division, London Headquarters, Department of Scientific and Industrial Research.

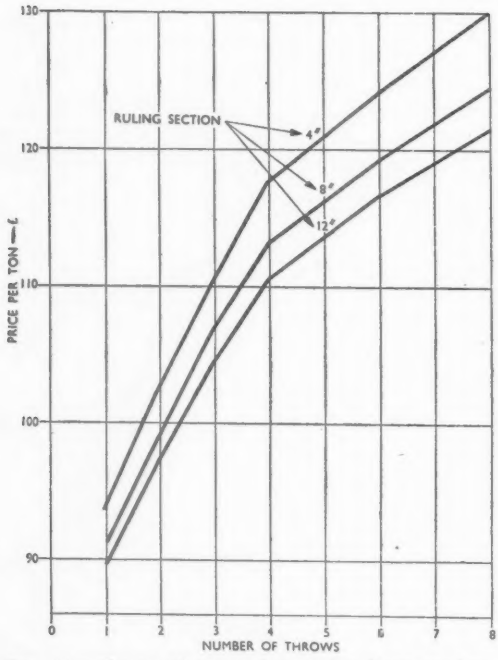


FIG. 14.—*Curves showing the relation between size, complexity, and price per ton for forged-steel crankshafts; black solid-forged shafts with one coupling flange, in 2½ per cent. nickel steel.*

ductility, annealed nodular cast iron is better than blackheart malleable iron, and incomparably better than ordinary grey cast iron. However, at the higher tensile-strengths, both heat-treated and as-cast nodular irons are much inferior in ductility to the cast carbon-steels. It seems rather unlikely that nodular cast iron will ever compete in cost with malleable iron in normal section thicknesses (for example, up to 2 in.) except in instances where the as-cast material has adequate ductility: there may, of course, be many such instances. Although it is possible to produce blackheart malleable iron in sections as thick as 4 in., this is rarely done in practice because the cost of annealing large castings at 900 deg. C. (1,652 deg. F.) for periods of up to 60 hours is prohibitive. Annealed nodular cast iron may well occupy this field, for the six-hour heat-treatment it requires is very much less expensive. As-cast nodular iron will hardly compete with carbon steel in simple castings, but it will compete in those instances where its better founding properties either offer a clear advantage in the proportion of sound castings poured, or make it possible to cast a component which it would be impossible to cast in steel or which it would cost more to fabricate by welding.

Quite apart from its improved founding properties, two great advantages which nodular cast iron appears to possess over cast steel are the greater ease with which it can be used with shell moulds in a mass-production foundry (because of its lower pouring temperature), and the simplicity with which it can be surface-hardened by chill-casting, flame-hardening or induction-hardening, without the need for an expensive carburizing process. The former property may give it a great advantage in the production of automobile crankshafts (see under nodular-cast-iron crankshafts, later) and the latter in the manufacture of such things as rolls, gears, cams, and ploughshares, which need a hard, wear-resistant surface.

When fatigue loading has to be taken into consideration, nodular cast iron loses much of its strength advantaege as compared with high-grade flake-graphite cast-irons; however, its fatigue properties are probably little inferior to those of cast carbon-steels, about the notched fatigue-strength of which there is little published information. All four cast alloy-steels tested by Love (1951) during his research work on cast crankshafts showed a fatigue-strength reduction-factor (notched) of 1.5, and if it be assumed that this figure also holds for the cast carbon-steels of lower tensile-strength, their notched fatigue-strengths as deduced from the results of Moore (1926) are much the same as those of nodular irons of similar tensile strength.

Under impact conditions, nodular cast irons are somewhat better than flake-graphite grey cast irons, their degree of superiority increasing as their ultimate tensile-strength falls. However, their impact resistance is very poor compared with that of the cast steels, and engineers will regard with some suspicion their employment for components which have to withstand sudden shock-loads. They would not be likely to show up very well in naval applications where high shock-loads from under water explosions are likely to be experienced.

Nodular Iron *v.* Light Alloys for Aeronautical Applications at Elevated Temperatures

Because of the comparative ease with which thin sections can be cast in nodular iron and because the material retains its strength up to moderately high temperatures, aeronautical engineers are becoming interested in its use for castings which operate at temperatures which are too high for existing light alloys. One such casting is the turbo-jet engine compressor casing. At 700 m.p.h., the temperature of the air leaving this casing may be well over 300 deg. C.; at 1,000 m.p.h. it will be 50 deg. C. hotter. Besides carrying the continuous bursting stress arising from the internal air pressure, the casing has to withstand high gyroscopic loads of short duration when the aircraft pitches or turns, and the casing cannot easily be cast in steel because a sound casting would require a very thick section, necessitating expensive machining to reduce the weight to a reasonable figure. One alternative would be to fabricate the casing in mild steel by welding, but the distortion likely to accompany such a process can well be imagined. A second alternative is to cast the casing in nodular iron (Fig. 9).

For this type of application, the important property is the strength: weight ratio of the material, that is, its specific strength. Figs. 15 and 16 show the variation of specific ultimate tensile strength and specific 0.1 per cent. proof stress with temperature for the seven materials which are fully described in Appendix III.

It will be noted that above 200 deg. C. mild steel has a higher specific ultimate tensile strength than any of the light alloys, though its specific limit of proportionality is less than the specific 0.1 per cent. proof stresses of most of the light alloys up to 300 deg. C. The data for nodular cast iron are unfortunately limited to room temperature and to temperatures above 425 deg. C. The properties of this material over the range 200-400 deg. C. may be important, and deserve urgent investigation. It seems very difficult to believe the very high limit of proportionality quoted by Saunders and Sinnott (1953) for nodular cast iron at 425-450 deg. C. and in the Author's opinion this requires corroboration. Should later tests confirm their results, it will be certain that nodular cast iron compares very favourably with all other materials as regards production man/hours, cost and mechanical properties for gas-turbine compressor casings operating at temperatures which are likely to be experienced in the near future.

Probable Output Trends

If the 1953 output of nodular cast iron in the United Kingdom, expressed as a percentage of the total output of iron castings of all kinds, reaches the figure which applied in the United States in 1952—which is, in the Author's opinion, a most optimistic forecast—the annual production will be about 10,000 tons. Allowing for a five-fold increase over the next seven years, Britain might be expected to be producing 50,000 tons of finished nodular-iron castings in 1960. Using basic-lined melting cupolas, direct-addition methods for introducing the magnesium, and subsequent B.C.I.R.A. cerium-treatment to guarantee reliable results, production of the 100,000 melt tons of nodular cast iron required would consume only 150 tons of magnesium and 20 tons of cerium *mischmetall*: these figures represent 2½ and 20 per cent. of the present British production of these metals. The amount of cerium *mischmetall* at present being used in the production of nodular cast iron is small: there would be no difficulty in finding an extra 20 tons in seven years' time, for ample supplies of monazite sand are available in India and South Africa, and production of the metal could easily be increased. This is already being done to meet the demand for high-strength magnesium and rare-earth-metal alloys for use in aeronautical applications.

Long-term increase in the output of nodular cast iron in the United Kingdom is governed by its selling price and by the availability of low-phosphorus ores. Makers of nodular cast iron will be more dependent than the steelfounders on an adequate supply of low-phosphorus pig-iron, for whilst it is easy to dephosphorize steel in the (discontinuous) Bessemer converter or basic open-hearth process, no one has yet discovered how to dephosphorize iron in the (continuous) cupola melting process. The United Kingdom already imports 90 per cent. of its consumption of hematite, chiefly from French North Africa and Spanish Morocco, while home production is dwindling as deposits in Cumberland are gradually worked out. Future prospects for the availability of cheap low-phosphorus ore in Britain are poor, and without cheap low-phosphorus ore or a new cheap method of reducing the phosphorus content of iron from the cupola, it seems unlikely that nodular cast iron production will ever be very large. In time of war, when the engineer might look to nodular cast iron to help to relieve the inevitable shortage of steel castings and forgings, the importing of low-phosphorus ore becomes difficult, and the amount which would then be available is problematical.

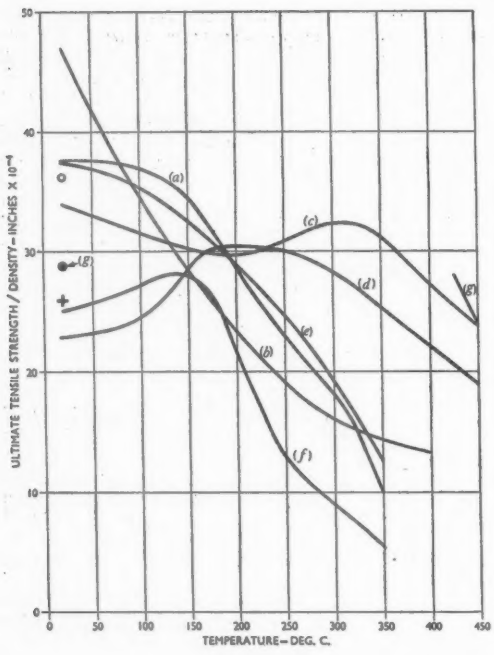
North America, on the other hand, has plenty of low-phosphorus iron ore; there are large deposits of bastnaesite in California from which to obtain *mischmetall;* and then there is the advantage of cheap electric power which is necessary for the economic production of both magnesium and cerium. Difficulty is therefore unlikely to be experienced in finding any of the materials used in the nodulizing process. The ultimate output of nodular cast iron in North America will be determined simply by competition in price and properties as compared with steel and ordinary high-grade grey iron.

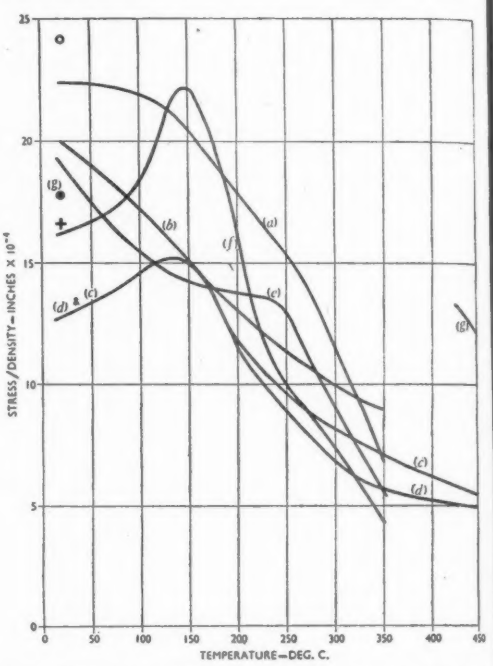
Scarcity of Nickel in Time of Emergency

It must be borne in mind that nodular cast irons made by the magnesium/nickel process contain quite an appreciable amount of nickel. The 21 nodular irons tested by Palmer and Gilbert (1953) had nickel contents varying between 0.54 and 3.37 per cent., the average being 1.7 per cent. When nickel is very scarce, it is arguable that it is better to make it into engineering steels of high strength, ductility, and impact resistance, rather than to use it merely as a vehicle for getting magnesium into solution in cast iron, where the final product has properties which are hardly comparable with those of alloy steels. Nodular irons produced from pig-iron melted in basic cupolas would probably have nickel contents of about 1 per cent., but nickel becomes so scarce in time of war that it is doubtful whether any could be spared for making nodular cast iron, even with a nickel content as low as this, except for important Service applications. It would not, of course, be needed if the alternative (mechanical) process for getting the magnesium into solution were adopted.

NODULAR-CAST-IRON CRANKSHAFTS

There has recently been some difficulty in obtaining crankshafts, particularly large shafts, for reciprocating internal-combustion engines, as reported by the British Internal Combustion Engine Manufacturers' Association (Macassey and Cooper 1951). These shafts are normally made of forged steel, though cast steel and high-grade flake-graphite cast-iron shafts have been used in some of the less-





(o) Room temperature value for a good pearlitic nodular cast iron: (+) Room temperature value for a good ferritic nodular cast iron; (*a*) RR.250; (*b*) ZT1; (*c*) 0.53 per cent. carbon steel; (*d*) 0.17 per cent. carbon steel; (*e*) ZRE1; (*f*) RR.50; and (*g*) results of Saunders and Sinnott (1953) for an as-cast nodular iron.

FIG. 15.—*Curves showing variation of specific ultimate tensile strength with temperature.*

FIG. 16.—*Curves showing variation of specific* 0.1 *per cent. proof stress (light alloys) or specific limit of proportionality (ferrous metals) with temperature.*

highly-rated engines. It is of interest to compare the various properties of crankshafts made in these three materials:

Ductility. In the Author's opinion, high ductility is not a requirement for crankshafts of any kind. He is aware that many marine engineers may quarrel with him here, but that is his opinion. The Author cannot see how a crankshaft can possibly continue to function satisfactorily if it is overloaded to such an extent that plastic yielding takes place; it might just as well have broken.

Surface Finish and Surface Hardness. The journals and crankpins of crankshafts require a high surface finish to provide the best possible conditions for hydrodynamic lubrication. There is no requirement in these members for the porous surface which is so necessary in a cylinder bore, and which is so well provided by certain flake-graphite cast irons. High-grade flake-graphite cast irons can be given a surface finish which is adequate for crankshaft-bearing surfaces. Nodular cast irons can also be machined to a very high surface finish, as will be evident from the appearance of some of the cast crankshafts illustrated in this Paper, for example, Fig. 17.

The surface hardness required of a journal or crankpin depends on the type of bearing material with which it is required to operate, the cleanliness of the oil used, and on the working life desired between crankshaft re-grinds. With white-metal bearings, a high degree of surface hardness is not essential: the white metal adapts itself to the contour of the shaft, and allows particles of grit from the oil to bury themselves in it. The embedded particles of grit proceed to lap the journals and pins, but the former are usually so much harder that the rate of wear of the shaft is not very sensitive to changes in its surface hardness over the range experienced with normal crankshaft steels. If a local high-spot develops, the bearing material can quite easily flow and redistribute the bearing pressure as necessary. The 24-35 Brinell hardness of the bearing metal at room temperature falls to 12-15 Brinell at 100 deg. C., so that prolonged operation at high oil-temperatures must be avoided if long life is desired.

Where the gas loading is either high or persistent, or both, as in compression-ignition engines, aircraft engines, or two-stroke engines, or where the oil temperature is very high, copper/lead bearings may have to be used. As first developed for aircraft engines in the early 1930's, they contained a small percentage of tin and were relatively hard. Such bearings demanded shafts with very hard surfaces and these were normally produced by nitriding suitable alloy-steels. Modern copper/lead bear-

ings contain very little tin (usually about 0.2 per cent.) and are very little harder than white metal at room temperature; their normal Brinell hardness range is 30-40, and this only falls to 25-35 at 100 deg. C. They can be used successfully with shafts having a hardness as low as 200-250 Brinell, provided that particular attention is paid to oil filtration. Even so, high shaft-hardness is desirable, as it must assist the maintenance of a high surface finish and a low rate of wear over a long operating life.

It will be seen from Fig. 10 that the surface hardness of annealed nodular cast iron is a little greater than that of steel of similar ultimate tensile-strength; as-cast nodular irons are much harder, the normal range being 250-300 Brinell in the ultimate-tensile-strength range of 45-50 tons per sq. in. This increased hardness may be a valuable feature of the material as it should improve bearing life. Furthermore, it is technically possible to flame-harden or induction-harden the crankpins and journals of a nodular-cast-iron crankshaft to produce a surface hardness of 600-750 diamond pyramid number, which approaches that obtainable from nitrided alloy-steels. It would be very valuable to carry out some fatigue tests on notched nodular-cast-iron components, which have been hardened in this manner, to discover what effect the treatment has on the notch sensitivity of the material.

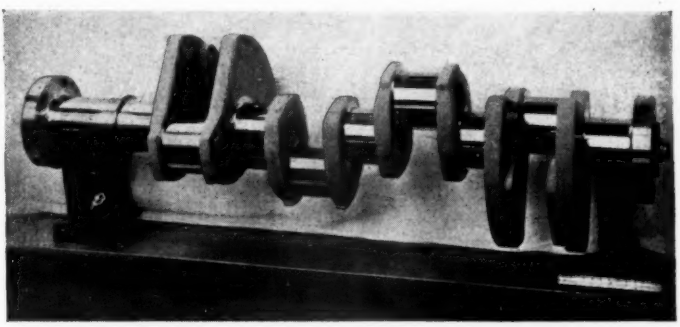
Fatigue Strength

One of the most important properties of a crankshaft material is its notched fatigue-strength both in bending and in torsion. Many reversed-bending-fatigue tests have been carried out by the Research Department of the Institution of Automobile Engineers (Williams and Brown 1940) and by the Motor Industry Research Association (Love 1950, 1951, and 1952) on drop-forged shafts in carbon and alloy steels, on cast shafts in flake-graphite irons and graphitic steels, on cast-alloy-steel shafts and on nodular-cast-iron shafts. The results of most of these tests are summarized in Appendix IV. The microstructure of a graphitic cast steel is shown in Fig. 18.

From inspection of this Table one might justifiably conclude that the bending-fatigue strengths of acicular, flake-graphite, cast-iron shafts, nodular-cast-iron shafts, and cast-alloy-steel shafts are in the ratio of 1:1.15:1.32, because all the shafts tested were of similar size and shape. One cannot go further and conclude that forged-carbon-steel shafts are twice as strong in reversed bending as acicular, flake-graphite, cast-iron shafts, because the forged-steel shafts tested were between 37 and 51 per cent. smaller in size than the cast shafts. As it is known that small notched shafts have a higher nominal fatigue-stress limit in reversed bending than large ones of similar shape, much of the apparent high fatigue strength of the forged shafts may have been due to their small size. It would be most interesting to see some results of tests on forged shafts of the same size as the cast shafts tested by Love, or perhaps, what would be even better from the point of view of the automobile engineer, to see some results of tests on cast shafts of smaller size, more representative of the size used in the majority of British car and motor-cycle engines.

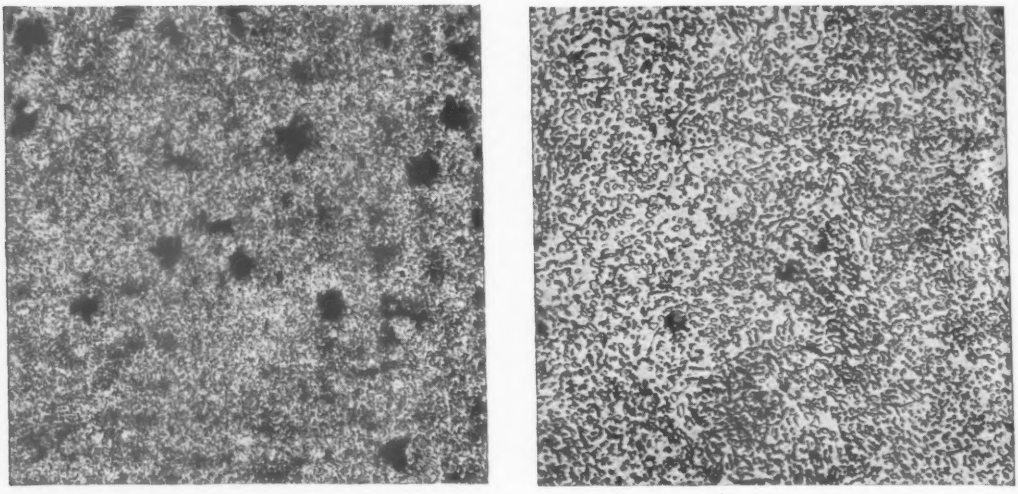
All that can be said from the published results of the bending-fatigue tests is that magnesium-treated nodular-cast-iron shafts are about 15 per cent. stronger than acicular, flake-graphite, cast-iron shafts. They are certainly weaker than drop-forged, carbon-steel shafts, but it will not be possible to say by how much until some truly comparative tests have been carried out, preferably on nodular-cast-iron shafts of crankpin diameter of about 2 to 2½ in.

It is unforunate that all the published work on the fatigue strength of cast crankshafts has been concerned with bending fatigue, for, in the Author's opinion, torsional fatigue accounts for more crankshaft failures in service. The relation between the notched torsional-fatigue strength and ultimate tensile-strength for some wrought steels, graphitic cast steels, malleable cast irons, and flake-graphite cast irons is shown in Table IV in Appendix V. For the small specimens concerned, the ratio is about 0.18 for the normal steels and graphitic cast steels, rising to 0.29 for the malleable cast irons and 0.33 for the flake-graphite cast irons. The very high figure for the latter may be one reason why flake-graphite, cast-iron crankshafts have given such good results in service. One might expect the ratio of notched torsional-fatigue strength to ultimate tensile strength for nodular cast irons to be somewhere between that for malleable cast iron and that for graphitic cast steel. The actual value is a matter of some importance and, in order that it may be determined, Lloyd's Register of Shipping have offered to undertake reversed-torsion tests on 3-in. dia. bars with various transition radii. Until the results of these tests are known, it will



[*Courtesy, Cooper Bessemer Corporation.*

FIG. 17.—*Large diesel-engine crankshaft in nodular cast iron.*



[Courtesy of Ford Motor Company, Limited.

FIG. 18.—*Microstructure of a typical graphitic cast steel, normalized and spheroidized* (*a*) (*left*) × 100; (*b*) × 1,000.

be prudent to assume that the notched torsional-fatigue strength of nodular cast iron is nearer 20 than 30 per cent. of its ultimate tensile strength.*

Impact Resistance

In the Author's opinion, crankshafts in normal usage are never subjected to rates of impact loading approaching those imposed in standard impact-machines used for materials testing. Rapid application of torque to a crankshaft can come from a piston suddenly encountering trapped oil, water, or liquid fuel during starting (for example, oil in one of the lower cylinders of a sleeve-valve radial-engine, or coolant which has leaked into the combustion chamber, or fuel which has got in as a result of overpriming) or from sudden engagement of the load (for example, if the clutch is suddenly engaged). In the former instance, the crankshaft speed is low and the blow is cushioned by the elasticity of the connecting rod; the connecting rod is much more likely to be damaged than the crankshaft. Sudden applications of load from the driven member are isolated from the crankshaft by the flywheel which will absorb most of the energy; if there be a clutch, the clutch will slip. In an automobile there is very great torsional flexibility between the flywheel and the road wheels, and sudden engagement of the clutch (or putting of the car into gear without releasing the clutch whilst the car is at rest) is much more likely to damage the transmission system than the crankshaft.

In war time, sudden shock loads may be applied to engines by the bursting near them of high explosives. In order to be quite sure that the impact strength of flake-graphite, cast-iron crankshafts was adequate for auxiliary engines used in naval applications, the Admiralty Engineering Laboratory carried out some very severe impact tests (Cape and Cheetham 1946) on a four-throw 3½-in. dia. crankshaft of this type, complete with flywheel, supported in its five bearings in a crankcase. The crankcase was flexibly mounted on a test plate to the under surface of which vertical blows from a 1,000 lb. tup could be applied, the tup falling freely about a horizontal axis from heights of up to 4½ ft. (Figs. 19 and 20). The vertical motion of the crankcase in the vicinity of the centre bearing immediately after the blow was measured with an electro-magnetic velocity-meter and the accelerations were deduced from these measurements. The cast-iron shaft withstood, without either cracking or permanent set, the heaviest blow which could be applied, vertical accelerations up to 162*g* being recorded. As a result of the successful conclusion of these tests, approval was given to the employment of high-duty grey cast-iron crankshafts in auxiliary engines for use by the Royal Navy.

If impact resistance were important in a crankshaft material, high-strength flake-graphite, cast-iron shafts would never have proved successful. Nodular cast irons have much better impact-resistance than these flake-graphite irons, so there should be no doubt that their shock resistance is adequate for crankshaft applications.

Elasticity and Rigidity

The elastic modulus (*E*) and the rigidity modulus (*N*) of a crankshaft material determine the shaft

*Since this Paper was written, later work by Love (1953) has made possible the deduction that there is a large scale-effect in notched torsional fatigue, the ratio mentioned falling to about 0.14 for graphitic cast steel and to 0.20 for flake-graphite cast irons when the shaft diameter is increased to 2.000 in.: the size effect seems to be greater in flake-graphite cast irons than it is in graphitic cast steel. Until reversed-torsion tests on large notched bars in nodular cast iron have been completed, it would be prudent to assume that the notched torsional fatigue strength of this material as used in engineering components is not more than 15 per cent. of its ultimate tensile strength.

deflection in bending and torsion under gas and inertia loads; they determine the bearing loads which will result from bearing malalignment; and they determine the torsional and longitudinal stiffness of the crankshaft and, hence, its natural frequencies in torsional and longitudinal vibration.

Average values of these moduli for the three materials concerned are shown in Table 1.

TABLE I.—*Average Values of Elastic and Rigidity Moduli.*

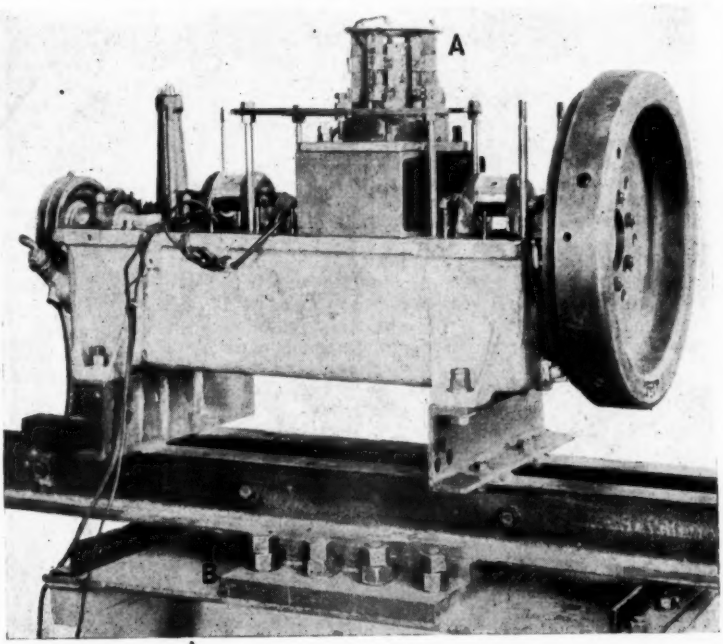
Material.	$E \times 10^{-6}$, lb. per sq. in.	$N \times 10^{-6}$, lb. per sq. in.	$\sqrt{N}$.
Acicular flake-graphite cast iron	20	8·1	2,840
Nodular cast iron (annealed)	24	9·6	3,090
Nodular cast iron (as-cast)	25	9·8	3,130
Steel	30	11·8	3,430

Under a given load, an acicular, flake-graphite, cast-iron shaft will deflect 50 per cent. more than a steel shaft of similar proportions; a pearlitic, nodular-cast-iron shaft will deflect 20 per cent. more. On the other hand, for a given bearing malalignment, the resulting bearing-loads will be 33 per cent. less with an acicular, flake-graphite, cast-iron shaft than with a steel shaft; with a nodular-cast-iron shaft they will be 17 per cent. less. Some research workers have proclaimed the low elastic-moduli of cast irons to be virtues in a crankshaft material because of the bearing-load relief they give under conditions of bearing malalignment. The Author considers them to be vices, because they result in increased angular or skewing deflection of the journals and crankpins in their bearings with consequent edge-loading of the bearings. The crankshafts of most high-speed internal-combustion engines are so flexible that the edge-loading arising from crankshaft distortion is more serious than the built-in loading due to malalignment, as can easily be seen by inspecting a set of car-engine or in-line aircraft-engine main-bearings after completion of a long working life; the bearings are almost invariably bell-mouthed and the wear near the ends is fairly uniform around the periphery, and not concentrated in a particular axial plane as it would be if bearing malalignment were the cause. Malalignment may, of course, be more important than shaft deflection in heavy stationary engines and marine engines having very stiff crankshafts, but the Author has had no experience of such engines.

Dangerous longitudinal vibration in crankshafts is generally confined to radial aircraft-engines having very light crankshafts which are comparatively flexible in bending and which carry heavy balance-masses. They will not be considered further here. Torsional vibration, on the other hand, is a potential menace in engines of all kinds and, if it is not fully considered, can reduce to naught the best efforts of the artist/designer. A change from a steel crankshaft to an acicular, flake-graphite, cast-iron crankshaft of similar design will drop the natural frequencies of torsional oscillation by 17 per cent.; a change from steel to pearlitic nodular cast iron will drop them by 9 per cent. Provided that during the design of the crankshaft due allowance is made for this change, there is no reason why the lower natural frequencies should be objectionable. However, in many engines designed around steel crankshafts, there is a dangerous critical speed just above the maximum operating speed—in fact, it is often the major factor limiting that operating speed. In such instances a material change from steel to cast iron without due consideration of its effect on the vibration characteristics of the engine may be disastrous.

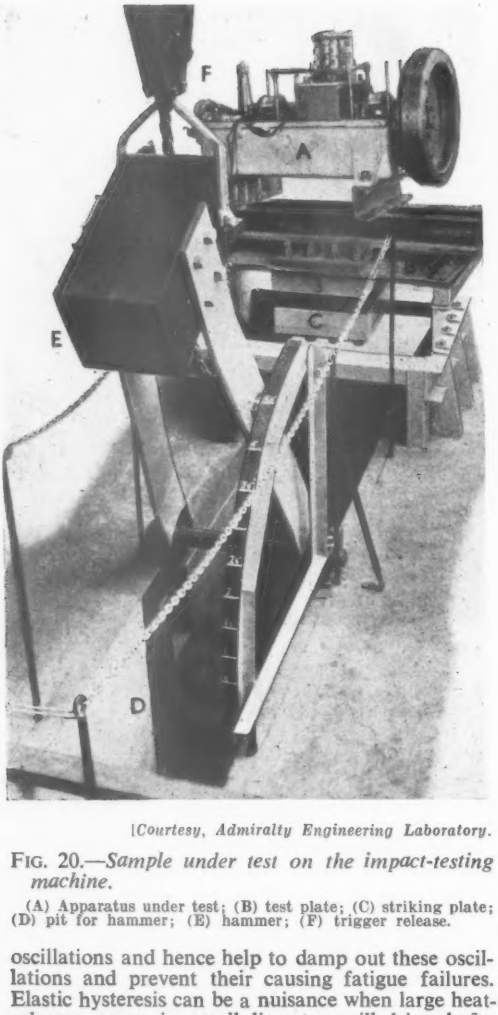
Internal Damping or Elastic Hysteresis

Elastic hysteresis can be of interest to the engineer in two ways. It can help him by dissipating as heat some of the energy periodically transformed from strain energy to kinetic energy during vibrations and



Courtesy, Admiralty Engineering Laboratory

FIG. 19.—*Crankshaft in its bearings on the impact-testing machine; (A) velocity meter and supports and (B) 1½-in. steel plate.*



[*Courtesy, Admiralty Engineering Laboratory.*

FIG. 20.—*Sample under test on the impact-testing machine.*

(A) Apparatus under test; (B) test plate; (C) striking plate; (D) pit for hammer; (E) hammer; (F) trigger release.

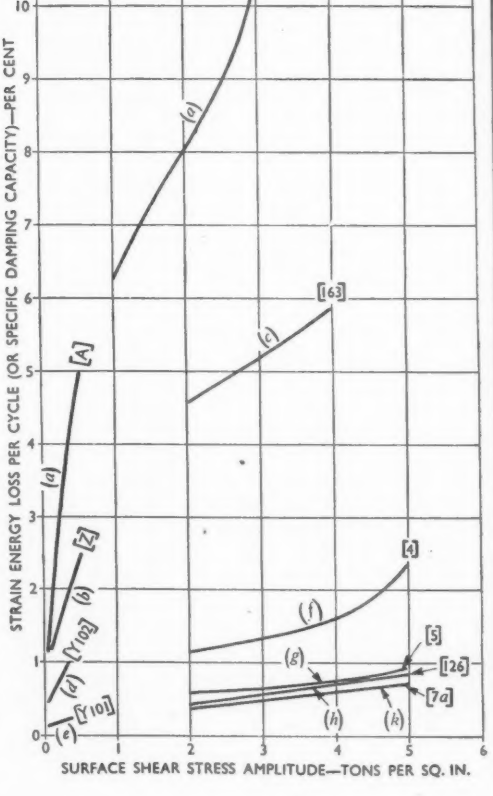
oscillations and hence help to damp out these oscillations and prevent their causing fatigue failures. Elastic hysteresis can be a nuisance when large heat-releases occur in small-diameter quill drive-shafts, which sometimes attain very high temperatures as a result. Internal damping in crankshaft materials can help to reduce vibration amplitudes and stresses at critical speeds, but the author shares the view of Shannon (1935) that, with crankshafts made from normal engineering steels, the greater part of the damping comes not from elastic hysteresis, but from hydrodynamic effects at the main bearings.

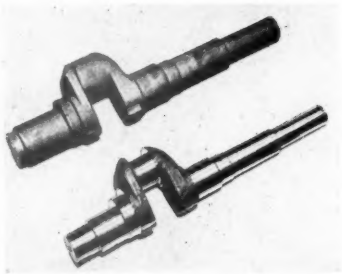
In Fig. 21 the strain energy dissipated per cycle has been plotted against the surface-shear-stress amplitude for several typical crankshaft materials and for nodular cast iron in the pearlitic and ferritic conditions. The sources of information from which these curves have been derived are Hatfield, Stanfield, and Rotherham (1942), Hatfield, Rotherham, and Harvey (1944), and Grant (1952). Hatfield and his co-authors used test specimens 0.312 in. dia.; Grant used specimens 0.200 in. dia. The figures and letters in square brackets adjacent to the various curves are the reference numbers used by the particular authors; they may be useful to those wishing further to identify the materials concerned.

From the information available it is evident that nodular cast irons in the as-cast condition have very little internal damping; when heat-treated, their elastic hysteresis is somewhere between that of high-grade flake-graphite irons and that of typical crankshaft steels. Measurements at much higher surface-stress amplitudes will have to be made before it can be stated with certainty whether the internal damping in as-cast nodular iron is more or less than that in crankshaft steels at stresses which are of in-

FIG. 21.—*Curves showing internal damping in torsion for various materials.*

(*a*) Pearlitic flake-graphite cast iron; (*b*) acicular flake-graphite cast iron; (*c*) inoculated flake-graphite cast iron; (*d*) nodular cast iron (heat-treated); (*e*) nodular cast iron (as-cast); (*f*) 0.36 per cent. carbon steel; (*g*) 3 per cent. nickel steel; (*h*) 0.51 per cent. carbon steel; and (*k*) 3½ per cent. nickel-chromium steel.





[Courtesy of Sheepbridge Engineering, Limited, and Petters, Limited.

FIG. 22.—6 *b.h.p. Diesel-engine crankshaft in nodular cast iron.*

terest to the engineer. In the Author's opinion, the contribution of elastic hysteresis to the damping of torsional oscillations in crankshafts of as-cast nodular iron is likely to be as small as it is in steel crankshafts. The gain in internal damping which can be obtained by annealing will never be worth the loss of fatigue strength and hardness which accompanies it.

Cost and Production Man/hours

Some indication of the relative costs and production man/hours appertaining to crankshafts in different materials have been given in an earlier section of this Paper. Nodular-cast-iron crankshafts made by the magnesium/nickel process, at present prices and using conventional moulds, would be much more expensive than shafts of high-grade flake-graphite cast iron, though their costs as fully machined might already compete with those of drop-forged steel shafts. They might become competitive with present cast-iron shafts if a cheaper nodulizing process were employed. Shell moulding lends itself admirably to the mass production of cast-iron crankshafts, and its employment will further reduce production costs. In the Author's opinion, it is only a matter of time before a fully machined nodular-cast-iron crankshaft can be offered at much the same price as an acicular, flake-graphite, cast-iron shaft, and at a lower cost (in terms of both man/hours and money) than a drop-forged shaft.

Viewing the properties of nodular cast iron in the light of all these different requirements for a crankshaft material, the Author would feel inclined to try a nodular-iron crankshaft in the as-cast condition for any internal-combustion engine which already uses a flake-graphite-iron shaft or which could afford the extra weight of such a shaft as compared with a forged-steel shaft of similar fatigue-strength. Stationary compression-ignition engines and marine engines should be able to use it with advantage. It would appear to be better to use the material in the as-cast condition rather than in the annealed condition, because fatigue strength and surface hardness are more desirable in this application than ductility and impact resistance. The designer should bear in mind the high notch-sensitivity of nodular cast iron as compared with flake-graphite cast irons, and should use the same large fillet-radii as he would adopt for steel shafts.

Mass-produced automobiles sold at competitive prices and others, which obtain high performance by the employment of large, low-rated engines, could use nodular-cast-iron crankshafts once their production costs became competitive. However, when one compares the notched fatigue strengths of nodular cast irons with those of forged steels, it seems doubtful whether the former could replace the forged carbon-steels used in most British car engines without some sacrifice in fatigue strength; it is quite evident that they cannot replace forged alloy-steels such as are used for crankshafts of high-performance engines without redesigning of the whole engine on a scale similar to that required when an alloy, grey-cast-iron shaft replaces a forged, alloy-steel shaft operating near its fatigue limit. In other words, the engine must be designed around the nodular-cast-iron crankshaft, and it will be a larger and heavier engine than before. The saving in cost on the crankshaft may easily be lost in the extra material required in the bigger engine, and in the reduced value of heavy engines as compared with light ones.

Several automobile firms in Britain already use alloy-cast-iron crankshafts, and all these would benefit by a change to nodular cast iron, if this material could be produced at a similar price and with equal reliability. In the United States, the Ford Motor Company has for twenty years used a cast, 1½ per cent. carbon, copper, silico/manganese iron (sometimes called graphitic cast steel) for its crank-

FIG. 23.—*Shell-moulded automobile crankshaft produced in the United States.*

[Courtesy of William Noyes.

Nodular Cast Iron

shafts (Cone, 1935, 1940), and its British subsidiary does likewise, despite the founding difficulties which must be experienced with a material having such a low carbon content. Reversed-bending tests, carried out by the Motor Industry Research Association (Love, 1950) on complete crankthrows cast in this material, showed that their fatigue strength was at least 15 per cent. greater than that of similar crankthrows cast in nodular iron. Wöhler tests on small specimens in these two materials, carried out by the same organization, showed that there was nothing to choose between their notched fatigue-strengths. One can only infer that, at the time when the nodular crankthrows were cast (1951), engineers in Britain had not yet learned how to make good castings in the new material. Since then, a British company has put nodular-cast-iron crankshafts in production for a small single-cylinder industrial Diesel engine (Everest, 1952) (Fig. 22), and several British automobile manufacturers are known to have obtained favourable results from experimental nodular iron crankshafts in prototype engines: some cast in shell moulds. Shell moulding makes it possible to mass-produce cast shafts to a very high degree of precision so that the very minimum of machining is required. Another shell-moulded iron crankshaft, this time from the United States, is shown in Fig. 23. One manufacturer in the United States has adopted nodular cast iron for his automobile-engine crankshafts, and is currently producing 10,000 a day, using the shell-moulding process (Higgins, 1952). The fact that this American motor company has changed from a graphitic-cast-steel shaft to a nodular-cast-iron shaft may be taken as a good indication that the cost of producing reliable nodular cast iron can be brought down to an economic level if sufficient trouble is taken. Should it prove possible to flame-harden, induction-harden, or chill-cast the bearing surfaces of nodular-cast-iron crankshafts without loss of fatigue strength, the resulting product will be extremely attractive to the engineer. It is to be hoped that fatigue tests on notched nodular-iron bars surface-hardened in this manner will be carried out by organizations interested in the further development of this material.

(To be continued)

Returning to B.I.S.R.A.

The British Iron and Steel Research Association has now chosen the successor to Dr. H. L. Saunders as head of its ironmaking division. He is Mr. E. W. Voice, who is at present assistant director of the Central Research Establishment II of the N.C.B. at Isleworth (Middx). He is, nonetheless, no stranger to B.I.S.R.A., or even to the ironmaking division. Mr. Voice, who takes up his appointment on June 1, went to B.I.S.R.A. with a B.SC. degree in special physics gained at London University. From 1946 to 1951, he was a member of the ironmaking division's staff, and was in charge of the field team at the association's North-East Coast laboratories when he left to take up his N.C.B. appointment. He is well suited to continue the work of his predecessor, for under Dr. Saunders he carried out much pioneering work on the chemistry and mechanism of the sintering process.

A.D.A.'s Officers

Managing director of the Birmingham firm of T. J. Priestman, Limited, and a member of the Institute of Metals for over 30 years, Mr. R. T. Priestman is the newly-elected president of the Aluminium Development Association. He joined the A.D.A. council in 1947 as the representative of A.L.A.R., Limited. He is a member of the council and late chairman of A.L.A.R., and also chairman of its technical committee. Mr. Priestman serves on the council of the Federation of Light Metal Smelters.

Others elected to office at A.D.A.'s annual general meeting were Mr. R. D. Hamer, of Aluminium Laboratories, Limited, as vice-president, and Mr. Harold Goodwin, of Birmetals, Limited, as chairman of the association's executive committee. Mr. Hamer, who was, of course, president of A.D.A. in 1953-54, introduced the report, which showed good progress with the three-year programme of research and development work begun in 1952, with particular emphasis on structural, marine, and the electrical engineering field. During the year part of the association's research activities culminated in the publication of no fewer than nine new research reports. There was also a continuation in the educational services, with a considerable increase in the use made of them. The demand upon the association's technical services increased in practically every direction.

Iron & Steel Output Records in April

Further output records were announced by the Iron and Steel Board on May 12. In spite of the effect in certain areas of the Easter holidays, steel production in April averaged 368,400 tons a week, which compares with the record output achieved in the previous month of 364,800 tons a week. The weekly average output of steel in April, 1953, was 348,500 tons.

Pig-iron production in April averaged 232,100 tons a week, this being 1,200 tons per week higher than in the previous month, when a new record was established.

Latest steel and pig-iron output figures compare as follow with earlier returns:—

Period.	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
	Tons.	Tons.	Tons.	Tons.
1954—1st qtr. ..	227,900	11,848,000	361,100	18,777,000
March ..	230,900	12,007,000	364,800	18,969,000
April ..	232,100	12,069,000	368,400	19,155 000
1953—1st qtr. ..	214,500	11,152,000	350,100	18,207,000
March ..	215,700	11,216,000	351,400	18,272,000
April ..	212,700	11,063,000	348,500	18,124,000

Latest Foundry Statistics

According to the Ministry of Supply, there were made during February 1,649 tons (*a*) of sand, 3,542 tons (*b*) of gravity-die, and 1,114 tons (*c*) of pressure-die aluminium castings; 29 tons of magnesium-alloy castings was also manufactured. The Bureau of Non-Ferrous Foundry Statistics states that the output of copper-base castings during March was 16,156 tons as against 12,725 tons in March, 1953.

In the April Bulletin of the British Iron and Steel Federation, employment showed a slight decrease in March in iron foundries. The total was 140,744 as against 140,871 in February. The decrease was greater in steelfounding, where there was a falling off of nearly 300, making the March total 20,305. The weekly average quantity of steel melted for making castings was 10,800 tons as compared with 11,000 for February and 11,600 for March last year.

"Safe Means of Access"

by M. S. Saint-Rich

Of all the cases that come up under industrial law in connection with injury to workpeople, few are more tricky than those based on the "safe means of access" condition in a working environment and none can involve the factory management more deeply in complex legal responsibility. It therefore behoves the foundry manager fully to comprehend the statutory rules and regulations that define his firm's responsibility in law and to follow intently such legal verdicts, that arise from time to time in legal actions and clarify obscure points and so establish the onus in a stated set of circumstances as to make definitive ruling for future cases of like nature. The phrase "safe means of access" sounds simple enough and of ready interpretation but experience has shown how the legal meaning of the term can differ and be made so pertinent as sometimes to involve the employer in high costs and personal damages.

The statutory implication is in section 26, subsection 1 of the Factories Act 1937, which demands that there shall, so far as is reasonably practicable, be provided and maintained safe means of access to any place at which any person has at any time to work. There has frequently arisen some confusion about just what constitutes a "means of access" which sometimes can shade into being an ordinary working place. This point came up, for instance, in the case of Fraser *v.* Mechans Limited when a chargehand supervising the removal of a pipe from one part of the factory to another, was injured when he attempted to prevent the pipe from coming into contact with a mobile crane standing in the roadway. The injured man sued his employers alleging a breach of section 26 of the Factories Act and the employers defended on the grounds that the roadway, was at the time of the accident, a working place and not simply a means of access. Lord Blades, however, in the Court of Session, refused to accept the employers' argument, saying that when the man had to pass along the roadway in the morning to reach his workplace there would be no possible doubt then, that the roadway constituted a means of access. In the opinion of the Court, the roadway could not suddenly, chameleon-like, change its nature and its statutory rôle, when, under the special circumstances of the accident, the employee had to leave one workplace with a component in order to transfer it to another workplace. Judgment was therefore given for the employee.

Another phrase that is sometimes clouded in interpretation is that of "so far as is reasonably practicable" because obviously there can enter into a set of circumstances, conditions that are temporary, unexpected and unpredictable. All these subtleties of a reading and application of the Act come up under legal scrutiny of a specific case and here the case of Latimer *v.* A.E.C. is definitive and illuminating:—

An employee fell and was injured as a result of slipping on a gangway floor that was temporarily flooded by a heavy fall of rain. He brought an action against his employers alleging breach of the "safe means of access" clause, and also a breach of the common law duty to provide a safe system of work. The judge held that there had been no breach of statutory duty but that there was breach of the common law duty and awarded damages to the employee. The employers appealed, and the Court of Appeal held that there was no breach on any issue, neither safe means of access nor common law duty of safe system of work. The matter then went to the House of Lords. At this final examination of the affair, it was stated that the question arose whether there was a statutory obligation to eliminate matter which was temporarily superimposed on a floor or whether the requirement applied only to the floor itself. A temporary obstruction such as a piece of orange peel would not make the floor inefficient, it was legally stated. If that were conceded, the question became one of degree. Lord Porter said that he could not think that the provision was meant to, or did, apply to a transient and exceptional condition. If the clause had been directed to such a state of affairs it would have been easy to say so. The employee's appeal was therefore dismissed.

Ruling Applied

That was an important and interesting legal decision and it was one that has since been acted upon by counsel. A case that recently came under the writer's attention was that of a workman returning early during the mid-day break to his workplace, who slipped on a patch of oil, broke his thigh, spent eight months in hospital and now has one leg three inches shorter than the other, is in constant recurrent pain and generally impaired in working and personal efficiency. He sought legal advice on whether he had a claim, but counsel, experienced in industrial cases, categorically stated that he had not. The oil had been spilt only a short time before by another workman, would probably have been cleaned up within a few hours and was definitely there as an exceptional and transient thing. That its presence rendered the passageway a dangerous road and that a safe means of access was not, during that period. available did not constitute a breach of section 26.

On the other hand, factory managers will do well to note that the whole stress lies on the "transitory and exceptional" conditions that for a limited period, constitute a hazard. If an employer allowed a means of access to remain covered with extraneous and hazard-creating matter for any length of time there is little doubt that an entirely contrary legal interpretation would be put upon the circumstances. If, for instance, the roadway in the case outlined above had been so badly maintained that floodwater readily collected, then a clear breach of the statutory

" *Safe Means of Access* "

rule would certainly have been found. The maintenance of those floors and ways that must provide the safe means of access is highly importantt.

Maintenance Important

Again, it is possible to exemplify and illustrate this point about maintenance by reference to a case heard in the courts and so offering a definitive interpretation. The case was that of Levesley *v* Thomas Firth and John Brown and it concerned two employees, who were returning to evening and overtime work after tea in the canteen. On the way to the canteen, the gangway that they had to traverse was wide and clear but on their return, a lorry had been parked therein covering half the width. Additionally, operatives leaving work were hurrying down the way so that one of the men attempted to walk through a narrow way left in the aisle on one side of the lorry. There was jutting into this narrow section of aisle, however, a thin piece of steel packing over which the man tripped, breaking his leg. In an action against the employers the man was awarded damages, the judge holding that there had been a breach of the safe means of access clause, section 26 of the Act. He argued that the employers had provided but had not maintained a safe means of access.

The matter might have rested there, on the maintenance issue, the legal attitude definitely holding the need for maintenance, but the employers pushed the case through to the House of Lords and there the point came up again about a *transitory* and exceptional obstruction. Lord Justice Singleton and Lord Justice Denning said that, as the lorry was standing only for a short period in the gangway, such obstruction did not represent a breach of the duty to maintain a passageway in effective condition as a means of access. The appeal was allowed, but stress was put on the fact that had the failure in maintenance been different, less casual, more inherent in the conditions, there would have been a breach of the duty.

To be on the right side, a foundry manager is wise who takes all precautions even with what could figure as " transient " hazards. With operators moving all over the works day after day, there is every need to overhaul all roadways and passageways and maintain them in proper condition. That there is indifferent maintenance is all too lamentably exemplified by tours of factories where potholes in the road are frequent, worn and rutted surfaces are to be found, and cluttered gangways reveal conditions of poor housekeeping. Matters may " tick over " for years under such conditions but if serious injury and a legal claim follows, a manager may well find himself without an acceptable defence.

British Chemical Standards

A meeting of about 50 analysts co-operating with Bureau of Analysed Samples, Limited, was held at York early this month, to discuss a report covering the ninth period of working *viz:* December, 1949, to November, 30, 1953. Dr. E. Gregory was in the chair and representatives were present from the British Cast Iron Research Association, the British Iron & Steel Research Association, the Naval Ordnance Inspection Department, research laboratories of the Brown-Firth Group, the United Steel Companies, Stewarts & Lloyds, Limited, Dorman Long & Company, Limited, Edgar Allen & Company, Limited, the General Electric Company, Limited, and the British Aluminium Company, Limited, and in addition there were chemists from a number of iron and steel works and engineering works throughout the United Kingdom.

The managing director of Bureau of Analysed Samples, Limited, Mr. N. D. Ridsdale, gave a report on the progress made during the four years ending November 30, 1953, and indicated that as a result of a number of requests made at the previous meeting of co-operating chemists, held November 28, 1950, the following new analytically standardized samples had been prepared:—

Three basic slags for total sulphur.
A stainless steel stabilized with niobium.
Two magnesium/aluminium alloys conforming to specifications D.T.D. 300 and D.T.D. 165.
A white iron, for total carbon (to avoid errors due to graphite).
A " pure " iron prepared mainly as a base metal with accurately determined traces of impurities.

Another important series of seven spectrographic standards to be known as the " mild-steel residual series " is in course of preparation in collaboration with the British Iron & Steel Research Association. This series contains increments of the common residuals including several others not usually found in mild steel, such as tungsten, titanium, zirconium, niobium, tantalum, magnesium, lead, and boron. This series is not likely to be available for about 12 months. Other new standards in course of preparation are:—a permanent-magnet alloy containing niobium; a silica brick; an aluminous brick and a 5 per cent. silicon/aluminium alloy to B.S. 1490:LM-16.

New Premises and Progress

Mr. Ridsdale mentioned that an important step was taken about a year ago, when it was decided to move to more commodious premises, *viz.* Newham Hall, a few miles outside Middlesbrough. These premises had provided better and larger machine-shops for turning and milling metal samples, also better accommodation for storing, packing, and despatching samples.

The managing director concluded by saying that the work of the Bureau had been greatly assisted by the willing help and guidance given not only by the honorary advisory committee, but also by many other co-operating analysts, also the firms who had supplied the bars, castings, and other raw materials from which the standard samples were prepared.

Mr. Peter Ridsdale then gave a report dealing with the progress made in the demand for standards at home and abroad. He stated that the increase in demand during the last few years was up 82 per cent. The greatest demand was for plain carbon steels, but there was an increasing demand for both high- and low-alloy steels, cast irons, ferro-alloys and non-ferrous materials. The demand for spectrographic standards was also steadily increasing. About 26 per cent. of the standard samples had been exported abroad to Europe, Asia, Africa, and America—France heading the list.

Personal

MR. J. D. MATHER, of Mather & Smith, ironfounders, has been elected to the Ashford, Kent, Urban District Council. Both his father and his grandfather served on the same Council.

SIR JOHN COCKCROFT, director of the Atomic Energy Research Establishment at Harwell, and chairman of the defence research policy committee, has been elected president of the Institute of Physics.

MR. G. M. MENZIES, chairman and managing director of North British Steel Foundry, Limited, Bathgate, has succeeded MR. F. N. LLOYD as vice-chairman of the British Steel Founders' Association, upon the election of Mr. Lloyd as chairman.

MR. W. H. MCFADZEAN, deputy-chairman and chief executive of British Insulated Callender's Cables, Limited, will become the chairman of the company on the retirement of SIR ALEXANDER ROGER, K.C.I.E., immediately after the annual general meeting on June 10, 1954.

MR. B. BLOMLEY, who since 1952 has been personnel manager of Blackstone & Company, Limited, Diesel-engine makers, electrical engineers, etc., of Stamford (Lincs), has been appointed personnel manager of the British Tyre & Rubber Company, Limited, Leyland (Lancs).

AFTER SOME 20 years on the staff of Peglers, Limited, brassfounders, of Doncaster, MR. LESLIE BEER and MR. SAM PEARCY have been appointed joint managers of the company's London depot. Since 1946 they have both been employed as sales representatives and have been working from the company's London office.

MR. H. A. STOCK, chairman and managing director of Peterborough Die Casting & Machine Company, Limited, has entertained more than 100 of his employees and their friends at dinner as a mark of appreciation of their loyalty and co-operation during his recent illness and subsequent convalescence.

DR. JOSEPH WILLIAM CUTHBERTSON, assistant director of research at the Tin Research Institute, has been elected to the recently endowed Cripps Chair of Metallurgy at the University of Nottingham from October 1, 1954. He is a graduate of Manchester, where he was also on the staff of the Department of Metallurgy from 1928-44.

MR. ROBERT DICK, blast-furnace superintendent of Pease & Partners Normanby Iron Works, Limited, Middlesbrough, has retired after 42 years with the company. He was in turn chemist, chief chemist, head of the refined-iron department, and blast-furnace superintendent, in which position his son, MR. I. M. DICK, succeeds him.

SIR GEORGE BRIGGS, president-elect of the Institute of Vitreous Enamellers, has been appointed a director of the Brush Group. Sir George is a director of Tube Investments, Limited, and is a member of the Royal Ordnance Factories Board. He was Deputy Controller, Iron and Steel Supplies, at the Ministry of Supply, from 1942 to 1945, and Deputy Controller of Supplies (Munitions Production), Ministry of Supply, from 1951 to 1952.

LORD PROVOST JOHN G. BANKS has been appointed chairman of the Governors of the Heriot-Watt College, Edinburgh. MR. A. G. THOMSON, lecturer in the Electrical Engineering Department of the college since 1945, has resigned. Mr. Thomson has been appointed the first principal of Kingston Technical School, Jamaica. He will also be adviser to the Government of Jamaica on the development and expansion of technical education in the island.

MR. E. D. KEEN, assistant chief designer of Sir W. G. Armstrong Whitworth Aircraft, Limited, has been awarded the Simms Gold Medal by the Royal Aeronautical Society for a paper on integral construction which in addition to being read in this country, has attracted attention on the Continent. Mr. Keen joined the firm in 1929 and has been closely associated with the development of the A.W.52 "flying wing," the first jet-powered, tail-less aircraft to be seen in this country.

MR. NORMAN LANCASTER, chairman of George H. Hughes, Limited, and a director of Joseph Lucas (Industries), Limited, as well as of the Midland Region of the Federation of British Industries, was installed as president of the Birmingham branch of the Incorporated Sales Managers' Association in Birmingham on May 17. In his presidential speech, Mr. Lancaster said that selling was very often the most important matter in business. "It is more like an art than a science because it does call for the exercise of the greatest quality of the human mind, imagination," he said. The new branch chairman is MR. S. A. GOODE, who was installed by the retiring chairman, MR. J. B. HASSETT.

FOLLOWING UPON the resignation of MR. B. WM. PAYNE, MR. E. J. LEAVER has been appointed manager for Carron Company, ironfounders and engineers, Carron Falkirk, Stirlingshire. The appointment became operative on May 15. Born in Middlesbrough, Mr. Leaver possesses a wide and varied knowledge of works administration gained in appointments held with William Whitwell & Company, Limited, Thornaby-on-Tees, United Steel Companies, Limited, Scunthorpe, and Stewarts and Lloyds, Limited, Birmingham. Mr. Leaver joined Carron Company in 1942 as cost accountant. From this position he became chief accountant in 1950; in 1952, he was appointed assistant manager and from this post he now becomes manager.

Obituary

MR. ARTHUR AUGUSTUS KAY, of Grenoside, Sheffield, founder of Arthur A. Kay & Son, Limited, engineers, Ecclesfield Works, Sheffield, has died at the age of 68.

MR. LESLIE PHILIP WILKS, who was managing director of Fordath Engineering Company, Limited, West Bromwich, died on May 20, aged 61. He had been in ill-health for the last year or so but, prior to that, his work had brought him into contact with a wide circle of foundrymen, by whom he was held with great respect and liking. He joined Fordath in 1930, coming from the Sunbeam Motor Car Company of Wolverhampton, where he was foundry manager. It was in 1945 that he was appointed managing director.

MR. H. A. REINCKE, whose death has occurred in London, retired in 1936 from the chairmanship and managing directorship of Wm. Beardmore & Company, Limited, Glasgow, after playing an important part in reorganizing the engineering side of the business. He went to Glasgow University as a youth to study engineering. He did not graduate, but continued his studies on the Continent. In 1930, Mr. Reincke, holding directorships in various companies, returned to Glasgow to reorganize the business of Beardmore's. By the creation of debenture stock, mainly subscribed by the Bank of England, the company was able to survive the worst years of the depression.

British Blast Furnaces in the March Quarter, 1954

(These tables are published through the courtesy of the British Iron and Steel Federation.)

Derbyshire, Leicestershire, Notts, Northants, and Essex.

Name of firm.	In blast at end of the first quarter, 1954.					Weekly average in blast.	Total existing at end of quarter.
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Clay Cross	—	—	1	—	1	1	2
Ford Motor	—	—	1	—	1	1	1
Holwell Iron	—	—	3	—	3	3	4
Kettering Iron & Coal	—	—	2	—	2	2	2
New Cransley Iron & Steel	—	—	1	—	1	1	2
Renishaw Iron	—	—	2	—	2	2	2
Sheepbridge	—	1	1	—	2	2	2
Stanton Ironworks: Stanton-by-Dale	—	—	4	—	4	4.2	5
Staveley Iron & Chemical	—	—	4	—	4	4	4
Stewarts and Lloyds: Corby	—	4	—	—	4	4	4
Wellingboro' Iron	—	2	—	—	2	2	3
TOTAL	—	7	19	—	26	26.2	31

Lancashire (excl. N.-W. Coast), Denbighshire, Flintshire, and Cheshire.

Brymbo Steel	—	1	—	—	1	1	1
Darwen & Mostyn	—	—	—	1	1	1	1
Lancashire Steel Corp'n.	—	2	—	1	3	3	3
Summers, J.	—	1	—	—	1	1	1
TOTAL	—	4	—	2	6	6	6

North-West Coast.

Barrow Ironworks	2	—	—	—	2	2	4
Charcoal Iron	—	—	1	—	1	1	1
Millom & Askam	2	—	—	—	2	2	3
United Steel: Workington	2	—	—	1	3	3	3
TOTAL	6	—	1	1	8	8	11

Lincolnshire.

Appleby-Frodingham	—	8	—	—	6	5.6	7
Lysaght's Scunthorpe Works	—	3	—	—	3	3.6	4
Thomas, R., & Baldwins: Redbourn	—	2	—	—	2	2	3
TOTAL	—	11	—	—	11	11.2	14

North-East Coast.

Consett Iron	—	3	—	—	3	3	3
Dorman, Long: Acklam	—	3	—	—	3	3	4
Redcar	—	2	—	—	2	2	2
Cleveland	—	2	—	—	2	2	4
Bessemer	—	3	—	—	3	3	3
South Bank	—	—	—	2	2	2	3
Gjers, Mills & Co.	2	—	—	—	2	2	5
Normanby Ironworks	2	—	—	—	2	2	3
Skinningrove Iron	—	2	—	—	2	2	3
South Durham Steel & Iron:							
West Hartlepool	—	2	—	—	2	2	2
Cargo Fleet	—	2	—	—	2	2	2
TOTAL	4	19	—	2	25	25	34

Scotland.

Bairds & Scottish Steel: Gartsherrie	1	1	1	—	3	3	5
Carron	—	—	1	—	1	1	4
Colvilles: Clyde Works	—	3	—	—	3	3	3
Dixon's	—	2	—	—	2	2	6
TOTAL	1	6	2	—	9	9	18

South Wales and Monmouthshire.

Briton Ferry Works	1	—	—	—	1	1	1
Guest Keen Baldwins: Cardiff	1	2	—	—	3	3	4
Thomas, R., & Baldwins: Ebbw Vale	—	2	—	—	2	2	3
Steel Company of Wales: Margam	—	2	—	—	2	2.9	3
TOTAL	2	6	—	—	8	8.9	11

Pioneer of Steam and Gas

This year sees the 200th anniversary of the birth of William Murdock, who was for many years one of the outstanding figures in the firm of Boulton, Watt & Company. While in the company's employ in Cornwall from 1779 to 1797 he developed a vehicle propelled by high-pressure steam, but this was coolly received by the firm, as was his invention of an apparatus to distil gas from coal.

When Murdock, who had served for many years for a weekly wage of £1, asked for a rise to £2 2s., he was refused, and consequently left the firm's service. However, as Watt's patents, about which Murdock knew enough to make him very useful to a rival concern, were due to lapse in 1800, Boulton & Watt offered to re-engage him as manager of their Soho works at a salary of £1,000 a year, and he accepted.

Later the hint came from Paris that Philippe Lebon was distilling gas from sawdust, and in order not to be forestalled, the company allowed Murdock to develop his coal-gas ideas. Gas-making plant soon became an important item on its list of products. Murdock stayed with the Soho works until his death in 1839.

TO COMMEMORATE the anniversary an exhibition was opened of Murdock relics on May 22 at the Birmingham Museum of Science and Industry. Although every possible relic in the country has been brought to the show, the results indicate the scarcity of souvenirs of the man who pioneered gas lighting and the locomotive engine.

Former Ironfounder's Appeal Upheld

In a reserved judgment given earlier this month the House of Lords allowed an appeal by the Crown from an interlocutor of the First Division of the Court of Session affirming a determination of the General Commissioners for Income Tax that John Barr, formerly trading as Henry & Galt, Limited, ironfounders, of Paisley, was not liable to a balancing charge of £1,405 under Section 17 of the Income Tax Act, 1945, in respect of machinery and plant sold when he disposed of the business in 1946.

When the appeal was heard the Attorney-General, Sir Lionel Heald, said that the appeal was brought to resolve a conflict of judicial opinion between the Court of Session, who in the present case held themselves bound by a decision of the Court given in 1950, and the Chancery Division in England, who on two occasions since 1950 has declined to follow the Court of Session in their construction of Section 17.

Lord Morton of Henryton said that after the sale was completed in 1946 Barr retired from business, but the business was carried on by the purchaser, a Thomas Reid, as if there had been no change. Section 17 (1) of the Income Tax Act, 1945, laid down that a balancing charge might be made where machinery or plant which had been the subject of a depreciation allowance was sold "before the trade is permanently discontinued." The question was whether the sale to Reid took place before the trade was permanently discontinued, or whether the trade was permanently discontinued at the moment of sale, because the person who had previously carried on the trade permanently discontinued it as from that moment.

The language of Section 17 seemed to indicate that the legislature contemplated that a trade was not necessarily permanently discontinued when the person carrying it on sold the business to someone else. The true view, he thought, was that the section regarded the question whether the trade itself did or did not continue as being completely divorced from the ownership of the trade at any particular time. Further, it had for many years been a familiar conception in income-tax law that a business could continue notwithstanding that one owner went out and another came in. He would therefore hold that the trade now under consideration was not permanently discontinued when it was sold to Reid.

Lord Morton of Henryton added that he thought the present case was distinguishable from the case of the "Girl Eileen," by which the majority of the First Division held themselves bound. He would therefore allow the appeal. Lords Reid, Tucker, Asquith of Bishopstone, and Cohen agreed.

British Blast Furnaces in the March Quarter, 1954—*continued*

Staffordshire, Shropshire, Worcestershire, and Warwickshire.

Name of firm.	In blast at end of the first quarter, 1954.					Weekly average in blast.	Total existing at end of quarter.
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Goldendale Iron	—	—	1	—	1	1	2
Lilleshall	—	—	1	—	1	1	2
Round Oak Steel Works	—	—	1	—	1	1	2
Shelton Iron, Steel & Coal	—	3	—	—	3	3	3
Stewarts and Lloyds: Bilston	—	3	—	—	3	3	3
TOTAL	—	6	3	—	9	9	12
Sheffield.							
Park Gate Iron & Steel	—	2	—	—	2	2	2
GRAND TOTAL	13	61	25	5	104	105.3	139

Weekly Average Number of Furnaces in Blast during the March Quarter, 1954, and the Previous Four Quarters

District.	1953.				1954.
	March.	June.	Sept.	Dec.	March.
Derby, Leics., Notts., Northants, and Essex	27.0	26.8	26.5	26.9	26.2
Lancs. (excl. N.-W. Coast), Denbigh, Flint, and Ches.	5.4	6	6	5·9	6
Lincolnshire	13	13	12.6	12	11.2
North-East Coast	24.8	24	24	24.7	25
Scotland	9	8.5	9	9	9
Staffs., Shrops., Worcs., and Warwicks.	8.1	7.8	8.9	9	9
S. Wales and Monmouth	9	8.4	7.6	9	8.9
Sheffield	2	2	2	2	2
North-West Coast	7.15	6.6	8	8	8
TOTAL	105.45	103.1	104.6	106.5	105.3

The following companies have furnaces in course of construction or rebuilding:—Darwen & Mostyn Iron; R. Thomas & Baldwins (Ebbw Vale); John Summers; Appleby-Frodingham Steel Co.; Stewarts and Lloyds (Bilston); Lysaght's Scunthorpe Works.; Dorman, Long & Co.; Lancashire Steel Corporation; South Durham Steel & Iron (West Hartlepool); Steel Co. of Wales.

Board Changes

POWELL DUFFRYN, LIMITED—Sir Henry Wilson Smith, K.C.B., K.B.E., has been appointed deputy chairman of the board of directors.

WOLVERHAMPTON METAL COMPANY, LIMITED and its subsidiary, James Bridge Copper Works, Limited—Mr. R. E. Talbot has resigned from the Boards.

THE UNITED STEEL COMPANIES, LIMITED—Mr. T. S. Kilpatrick, director and commercial manager of Workington Iron & Steel Company, has been appointed a director of Distington Engineering Company, Limited. Mr. Kilpatrick will, from May 3, be commercial manager of both companies.

INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED—Consequent upon reaching retirement age, Dr. Paul D. Merica, president, and Mr. W. J. Hutchinson, treasurer, have been succeeded by Mr. Henry S. Wingate, formerly vice-president, and Mr. F. M. A. Noblet, formerly assistant treasurer, respectively.

News in Brief

THE ANNUAL CONVENTION and Spring excursion of the Finnish Foundrymen's Association was held at Karhula on May 22.

AN EXHIBITION of newly developed dust filters manufactured by Air Control Installations, Limited, Ruislip (Middx), will be held at the Imperial Hotel, Birmingham, on June 1 and 2.

THOMAS WARD, LIMITED, of Sheffield, have won the first of the annual awards made by *The Accountant* for reports and accounts of public companies. There was an entry of nearly 500 companies.

THE RT. HON. SIR WALTER MONCKTON, Q.C., M.P., Minister of Labour and National Service, has appointed MR. D. P. BUCKLEY to be his assistant private secretary in succession to Miss E. B. Fox.

THROUGH AN ERROR IN TRANSCRIPTION, incorrect particulars were printed last week in this column for the 1954 Motor Show. This will actually be held in London from October 20 to 30, at Earls Court.

R. J. RICHARDSON & SONS, LIMITED, announce that their works and offices will close down at 5.30 p.m. on Friday, June 4, for Whitsun holidays, and re-open at 8 a.m. on June 9. During this period goods will not be received or despatched.

ALUMINIUM BRONZE CASTING COMPANY (BALHAM), LIMITED, are now in full production at their new premises (behind Non-Ferrous Founders, Limited, of which firm they are proprietors) at Garth Road, Lower Morden, Surrey. Tel.: DERWENT 8866.

A MUG of Staffordshire pottery which belonged to James Watt, of Soho Foundry fame, and dating from 1809, will be on show at the Antique Dealers' Fair to be opened in the great hall of Grosvenor House, London, on June 9, by the American Ambassador

ENGLISH STEEL CORPORATION, LIMITED, Sheffield, has planned a new machine-shop for a site on Brightside Lane for the expansion of production. The new shop will cover 105,000 sq. ft. and will be used to increase output, *inter alia*, of forged-steel moulds for cast-iron pipes.

SMITH & WELLSTOOD, LIMITED, in their centenary celebration programme this month have included a series of sports competitions for employees (from May 1 to 28), a high tea, variety show and prize distribution, followed by dancing, on May 28, and a children's gala on May 29.

BY PERMISSION of H.R.H. the Duke of Gloucester, British Railways' latest express passenger locomotive is to be named "Duke of Gloucester," in commemoration of the Duke's honorary presidency of the International Railway Congress which was held in London from May 19 to 26.

KODAK, LIMITED, Wealdstone, Harrow, Middlesex, have issued information describing and pricing their X-ray processing unit, model 56, which is comprised of three 5-gallon tanks, one for developer (provided with a plastic cover) and two for fixer, each to take six film hangers of a size up to and including 14 by 17 in.

THE CONCLUSION of a £7,000,000 contract to supply textile machinery to Russia was announced in Moscow on May 19 by Mr. F. C. Seward, of Platt Bros. & Company, Limited, Oldham. The contract includes a subsidiary contract for machinery worth about £1,250,000, which Mr. Seward negotiated when he visited Moscow in January.

SINGAPORE is soon to start work on its first polytechnic college, to cost £1,000,000, and planned by Mr. A. W. Gibson, principal of the Dudley and Staffordshire Technical College. Mr. Gibson returned to Dudley on May 18, having been in Singapore since February at the invitation of the Government there to advise on the planning of the college.

CUPODEL, LIMITED, of Birmingham, makers of hot-blast equipment for cupolas, have as from April 1, last, become associated with the well-known firm of fan engineers, Keith Blackman, Limited. The registered office of Cupodel, Limited, is now at Mill Mead Road, Tottenham, London, N.17 and the Birmingham Office at 1,294, Bristol Road South, Northfield, Birmingham 31.

AS PART of an educational visit arranged by George Salter & Company, Limited, of the North and South Works, of High Street, West Bromwich, a party of employees from those works last week paid a visit to the foundry in Grice Street, West Bromwich. Here Mr. H. Bennett and Mr. T. W. Bates, foundry manager and foreman, respectively, explained exactly what happens in their share of the firm's activities.

ACCORDING TO Hungarian news and information service, there are more church bells in Hungary to-day than there were before the war. The Slezák Rafael State bell-casting firm had a rush of orders for bells for the Easter and Whitsun church festivals. Three bells weighing 1,000, 500, and 260 lb. were consecrated on Palm Sunday at Tótkomlós, and a 800 lb. bell is being cast for installation at Nemesvámos at Whitsun.

MR. C. E. WEBB, B.SC., of the National Physical Laboratory, Teddington, lectured on "Magnetic Testing" at a gathering arranged by the Permanent Magnet Association at the Royal Victoria Hotel, Sheffield, last week. About 200 representatives from local metallurgical and electrical industries were present. He said that the high quality of the permanent magnets made in Sheffield compared favourably with those from other countries.

FIFTY-SIX DRIVERS of Thomas Firth & John Brown, Limited, steel manufacturers, Atlas Works, Sheffield, have received safe-driving awards at a ceremony when Councillor F. C. Toplis, chairman of the Sheffield Accident Prevention Council, made the presentations. There were two for 26-years' accident-free driving. They were received by Mr. W. Fieldsend, chauffeur of the works Rolls-Royce, and Mr. J. W. Gregory, driver of a heavy lorry.

ONE OF THE HEAVIEST single loads to be handled by Prestwick Airport was shipped on Friday to Canada by Royal Dutch Airlines. The load was a four-ton cylinder-block for the Doris Steamship Company's vessel, Sun Rover, at present undergoing repairs at Halifax, Nova Scotia. The block was cast by John Kincaid & Company, Limited, Greenock, and was flown direct to Halifax by a specially-chartered Skymaster aircraft.

A 3-MOTOR electric overhead travelling crane having a span of 36 ft. 2 in. has been supplied to the Ministry of Works at the Atomic Research Station, Harwell, by Richard C. Gibbins & Company, Limited, Berkley Street, Birmingham. This crane has been designed for a safe working load of 5 tons and is fully controlled from the cage. A special feature is that the hoist motion can be operated at two speeds, either 15- or 30-ft. per minute by means of a change-speed motor.

THE LONDON OFFICE of the National Federation of Engineers' Tool Manufacturers has been closed, and

(*Continued on page* 624)

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News in Brief

(*Continued from page* 622)

from May 24 the work done there was transferred to the Sheffield office at Light Trades House, Melbourne Avenue, Sheffield. Mr. T. E. Williams, who has been in charge of the London office in Caxton Street, for the past five years, has been appointed assistant secretary of Sheffield Lighter Trades Employers' Association and will continue to deal with the work of associations affiliated to the Federation.

DURING A VISIT to the office appliance section of the British Industries Fair at Olympia, H.R.H. the Duchess of Kent, and her daughter, Princess Alexandra, were presented with an Empire "Aristocrat" portable typewriter made by British Typewriters, Limited, of West Bromwich. The model is known as "the most portable typewriter in the world," on account of its compactness and light weight. The presentation was made on behalf of the Office Appliance and Business Equipment Trades Association by Mr. Gordon Sloane, president.

MR. J. H. RUSSELL, works director of Hall & Pickles, Limited, steel manufacturers, Hydra Steel Works, Ecclesfield, Sheffield, was re-elected president of the Crucible Steel Makers' Association for the fourth successive year at the annual meeting at the Royal Victoria Hotel, Sheffield. Mr. W. Brazenall, of Walter Spencer & Company, Limited, steel and tool makers, of Warren Street, Sheffield, was elected a vice-president, and Sir Ronald Matthews, Sir Stuart Goodwin, Mr. W. Spencer and Mr. S. Levick were re-elected vice-presidents.

ON MAY 18, Viscount Brookeborough, P.C., C.B.E., M.C., M.P., the Prime Minister of Northern Ireland, accompanied by Lord Glentoran, M.P., Minister of Commerce, and Mr. W. N. McWilliam—assistant secretary to the Cabinet—visited the main works at Rugby of the British Thomson-Houston Company. The party was welcomed by Mr. E. H. Ball (managing director), Mr. W. W. Vinsen (director of manufacture), Mr. H. L. Satchell (director and manager Rugby works) and other executives of the company, who afterwards accompanied the visitors on their tour of the works.

SURMANCO, LIMITED, Cavendish Street, Sheffield, begin production of a new-type scissor—the changer-blade scissor—in June. Each pair has three sets of blades which are selected and assembled to give ordinary household scissors, pinking shears for the edges of cloth, or cutting-out shears. An American order for 72,000 pairs will be carried out first and this will take the first six months' output. Twelve thousand pairs will be made a month at first with perhaps an increase to 3,000 pairs a day later on. New tools have been installed by the firm since the order was received, and it is expected that the number of workers, now 330, will be increased.

R. J. JONES & SONS, 130, Wheelock, P.O. Box 991, Alexandria, Louisiana, U.S.A., wishes to receive quotations from U.K. manufacturers of cast-iron soil pipe and black and galvanized iron pipe. Interested manufacturers are advised to communicate with the company by air mail at the above address, and are requested to send a copy of their correspondence to the British Consulate-General, 1022, National Bank of Commerce Building, New Orleans, 12, Louisiana. They are also requested to inform the Board of Trade, Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (reference ESB/11030/54), of any action taken.

FOREMEN from many parts of the country attended a meeting in Birmingham on May 18 organized by the Birmingham Productivity Association and the Institute of Industrial Supervisors. The foremen posed questions relating to the supervisor's place in industry to a team representative of various phases of industrial administration. The chairman of the panel was Mr. J. A. Hunt, general manager of the Hymatic Engineering Company, Limited, Redditch, and members were Mr. Michael Clapham, joint managing director of I.C.I. Metals Division; Mr. J. Forster-Cooper, chief inspector of Joseph Lucas (Electrical), Limited; Mr. Frank McDonagh, a shop steward and fitter at the Standard Motor Company, Limited, Coventry, and Mr. William Sellers, a superintendent at a London cable works.

MR. R. E. NUTT, managing director of Court Works, Limited, gave his impressions of a recent visit to German foundries when he spoke at the annual staff dinner in Wellington on May 17. He said the foundry industry in the U.K. would have a difficult time in the future with more competition and need for higher quality. Mr. Nutt was greatly impressed with the control in German foundries. They had far more people engaged in research and control than in the average British foundry and work was of the highest order. On the subject of his own firm's progress, Mr. Nutt said that 1953 was a record year both in output and sales. The firm had started a new venture, making high-duty irons, and they were also carrying out research on a new malleable iron. It was hoped to have it on the market within a year.

MORE THAN 200 members of the Midlands Region of the Engineering Industries Association on May 20 went by special train from Birmingham to visit the 600-acre Abbey Steelworks of the Steel Company of Wales, Limited, at Margam, South Wales—of which many of them are customers. The visitors saw sections of a large expansion scheme in progress, expected to raise output by 50 per cent. Mr. W. F. Cartwright, director and general manager, explained that it would increase coke production from 15,000 tons a week to 23,000; pig-iron from 20,000 to 30,000; steel ingots from 33,000 to 44,000 and steel strip from 28,000 to 37,000. Tinplate production would be nearly doubled, and cold-rolled sheet output considerably increased. About 3,500 men were employed on the extensions which would raise the productive labour force from 10,500 to 13,500. A new blast furnace, the fourth, is being laid down to give an extra 10,000 tons a week of pig-iron; the melting shop is being extended and four 225-ton oil-fired steel furnaces installed. Also included in the scheme is a new five-stand tinplate mill at Velindre, near Swansea. The leader of the party was Mr. J. Bayliss.

Company Changes

FOLLOWING the death of Mr. J. T. Hobkirk, who had been chairman of J. Hobkirk, Sons & Company, Limited, since its formation, the directors have now decided upon the reconstruction of the Board with the effect that as from January 1, Mr. W. T. Hobkirk becomes the new chairman with his son, Mr. J. T. W. Hobkirk as vice-chairman. Mr. W. T. Hobkirk, who was managing director since the company was formed, is succeeded in that position by Mr. F. C. Baker, formerly works director. Mr. Baker has been associated with the firm since 1936.

Mr. W. T. Hobkirk also relinquished his appointment as company secretary to Mr. R. H. Mathews, so as to be free to give more time to his national commitments with the trade associations. Mr. Hobkirk is vice-chairman of the South of England Ironfounders' Association, a Council member of the Association of Bronze & Brass Founders, and a member of the Ironfounders' National Technical Committee.

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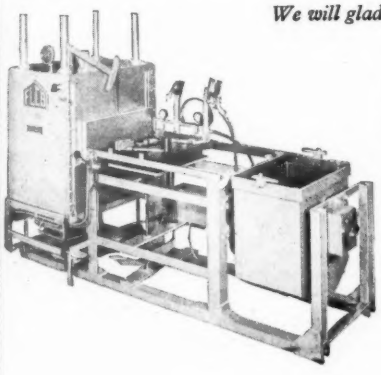

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Pig-iron and Steel Production

Statistical Summary of March Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table I summarizes activity during the past six months. Table II gives production of steel ingots and castings in March, and Table III, deliveries of finished steel in February, 1954. Table IV gives the production of pig-iron and ferro-alloys in March, 1954, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*Iron and Steel Price Index and General Summary of Pig-iron and Steel Production*

Period.	Price index, 1938 = 100.			Iron-ore outpnt.	Imptd. ore used.	Coke to blast-furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	I. & S.	Coal.	All comdts.						Imports.[1]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[1]
1952[2] ..	254	329	323	306	190	228	202	171	29	310	252	739
1953	260	350	323	304	207	237	215	188	18	339	261	1,011
1953—Oct. ..	261	352	321	288	226	237	222	202	12	355	280	986
Nov ..	260	358	323	292	232	245	229	206	15	363	283	994
Dec.[4] ..	260	359	321	297	229	244	225	192	12	339	256	1,011
1954—Jan. ..	259	358	321	307	234	246	230	203	10	360	275	989
Feb. ..	259	359	322	302	230	240	222	201	14	357	289	948
March	260	360	324	322	232	238	231	203	16	365	—	947

TABLE II.—*Production of Steel Ingots and Castings*

District	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex ..	—	3.4	10.9 (basic)	1.9	0.2	15.4	1.0	16.4
Lancs. (excl. N.W. Coast), Denbigh, Flints, Ches.	1.7	25.8	—	1.6	0.7	28.5	1.3	29.8
Yorkshire (excl. N.E. Coast and Sheffield) ..								
Lincolnshire	—	38.5	—	—	0.1	38.5	0.1	38.6
North-East Coast	1.7	71.9	—	1.2	0.4	73.4	1.8	75.2
Scotland	3.6	38.1	—	1.1	0.7	41.6	1.9	43.5
Staffs., Shrops., Worcs. and Warwick	—	17.3	—	1.1	0.8	17.4	1.8	19.2
S. Wales and Monmouthshire	5.3	74.5	4.4 (basic)	1.2	0.1	84.8	0.7	85.5
Sheffield (incl. small quantity in Manchester) ..	9.1	30.3	—	9.4	0.6	47.3	2.1	49.4
North-West Coast	—	1.0	5.6 (acid)	0.5	0.1	7.1	0.1	7.2
Total	21.4	300.8	20.9	18.0	3.7	354.0	10.8	364.8
February, 1954	20.8	295.7	19.2	17.9	3.7	346.3	11.0	357.3
March, 1953[4]	24.0	280.7	23.1	19.7	3.9	339.8	11.6	351.4

TABLE III.—*Production of New Non-alloy and Alloy Finished Steel.*

Product.	1952.[3]	1953.	1953.	1954.	
			Feb.	Jan.	Feb.
Non-alloy steel:					
Ingots, blooms, billets and slabs[5]	4.5	4.7	5.4	5.0	5.3
Heavy rails ..	8.0	8.7	8.8	10.1	11.6
Sleepers, fishplates	1.8	2.2	2.4	1.0	1.8
Plates ¼ in. thick and over ..	41.4	46.5	46.5	49.1	51.8
Other heavy prod.	39.0	43.9	45.7	49.2	47.6
Rods, bars in coil	15.9	15.6	17.5	19.0	18.6
Light rolled prod.	46.0	49.3	53.4	46.6	47.5
Bright steel bars ..	6.5	6.7	7.8	6.3	6.3
Hot-rolled strip ..	18.8	18.8	21.3	21.5	21.0
Cold-rolled strip ..	6.1	5.2	5.6	6.8	7.0
Sheets, incl. coated	31.6	33.4	33.9	36.0	39.0
Tinplate, terne-plate, blackplate	16.0	14.9	14.4	16.2	18.0
Steel tubes, pipes	20.1	20.1	22.6	18.8	20.0
Tube, pipe ftgs.	0.4	0.3	0.4	0.4	0.4
Mild wire	12.2	10.6	11.5	11.4	11.5
Hard wire	3.6	3.6	4.0	3.8	3.9
Tyres, wheels, axles	3.5	4.4	3.5	5.0	4.8
Forgings (excl. drop forgings) ..	2.8	3.1	3.4	3.0	2.9
Steel castings ..	4.2	4.0	4.2	4.1	4.1
Tool and magnet steel	0.3	0.3	0.3	0.3	0.3
Total	282.7	296.3	312.6	313.6	323.4
Alloy steel	13.7	13.9	16.1	14.0	14.1
Total deliveries from U.K. prod.[6] ..	296.4	310.2	328.7	327.6	337.5
Add: Imported finished steel ..	13.8	6.9	8.5	5.7	9.0
	310.2	317.1	337.2	333.3	346.5
Deduct: Intra-industry conversion[7] ..	60.2	57.5	66.9	59.4	59.1
Total deliveries of new material ..	250.0	259.6	270.3	273.9	287 4

TABLE IV.—*Production of Pig-iron and Ferro-alloys*

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	26	—	18.1	26.7	0.6	—	45.4
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire ..	8	—	15.4	—	—	1.1	16.5
Yorkshire (incl. Sheffield, excl. N.E. Coast) ..							
Lincolnshire ..	11	—	31.0	—	—	—	31.0
North-East Coast	25	4.4	50.9	—	—	1.2	56.5
Scotland	9	0.8	15.5	1.9	—	—	18.2
Staffs., Shrops., Worcs., and Warwick ..	9	—	7.7	1.6	—	—	9.3
S. Wales and Monmouthshire	9	5.0	29.9	—	—	—	34.9
North-West Coast	8	17.4	—	0.2	—	1.5	19.1
Total ..	105	27.6	168.5	30.4	0.6	3.8	230.9
February, 1954 ..	105	26.5	162.4	28.4	1.3	3.7	222.3
March, 1953[4] ..	105	26.4	154.3	29.9	0.7	4.4	215.7

[1] Weekly average of calendar month.
[2] Stocks at the end of the years and months.
[3] Average 53 weeks ended January 3, 1953, all tables.
[4] Five weeks, all tables.
[5] Other than for conversion into any other form of finished steel listed above.
[6] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
[7] Material for conversion into other products also listed in this table.

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Raw Material Markets

Iron and Steel

As yet the Iron and Steel Board has made no overt response to the demand for a readjustment of prices which will take cognisance of the advance in the cost of coal and coke. But it is evident that the economy of the steel and the foundry trades has been rudely disturbed and it is regarded as inevitable that some rise in metal prices must be conceded. Possibly the expectation has given some further impetus to the demand for prompt deliveries of pig-iron, but as current outputs are already going with immediate consumption there is not much scope for acceleration. Furnacemen engaged on the production of high-phosphorus iron are able to meet the specifications from their regular customers, but there are no surpluses of hematite or the low-phosphorus grades to permit of increased deliveries.

A revival in the re-rolling industry is long overdue and it may be just around the corner. At all events it is an encouraging development that a few export orders have been placed and as the movement for freer trade gathers momentum, hopes of returning animation in the re-rolling establishments is rekindled. During recent months consumers have been limiting their purchases of steel semis to their immediate requirements, and British steelworks are now in a position to provide bigger tonnages without reversing the steady shrinkage of imports. The increased consumption of sheet bars and slabs is also well covered from home sources and demand promises to be sustained at a high level to the end of the summer.

Apprehension of a further rise in prices constitutes the one cloud on the horizon of the steel industry. In all other respects the tone of the market is confident and fears of redundancy have been dispelled by the upward trend of productivity in all the chief consuming industries. Export demand, hitherto confined chiefly to sheets and plates, is extending to a wider range of products, while the expansion of home trade is keeping pace with the continued rise in the output of other classes of rolled steel. Producers of heavy joists and sections have an impressive weight of orders in hand, and sheetmakers are now only able to accept new business on extended delivery terms.

Non-ferrous Metals

Copper statistics for April, published by the Copper Institute in New York, confirm the improvement in copper in the United States since the beginning of the year. Deliveries to domestic consumers have once again topped 100,000 short tons. There has been a rising trend since January and the April figure shows an improvement approaching 30,000 tons. Total deliveries in April were 104,829 tons, a gain of just over 9,000 tons on March. Output of crude copper in April was 77,063 tons, compared with 81,100 tons in March, while production of refined copper amounted to 112,617 tons, compared with 117,546 tons in the previous month.

Stocks of refined copper in producers' hands at April 30 were 124,523 tons, against 125,759 tons at March 31. During the first half of last year, usage of copper in the United States was running at well over 100,000 tons monthly, but in the second half it fell away. Now it has climbed back to a satisfactory total, which, so far as April was concerned, exceeded output of crude by some 28,000 tons. This must mean that imports will be at a rate to bridge the gap, and, doubtless, Chile will benefit.

On the Metal Exchange last week, an easier tendency was noticeable. In tin the backwardation virtually disappeared, for L.M.E. stocks have improved considerably. Not much has been heard lately of the international tin agreement, but some encouragement was provided by news that India was signing as a consumer. Even so, more consumer votes are required to bring the agreement into being. It was thought that there would be no doubt about producing countries' signing, but Indonesia's decision has not as yet been made and her adherence will be necessary if the scheme is to come into existence. Although the second half of last week brought some recovery in values, markets were easier on balance.

Copper, which closed well above the worst, was, nevertheless, £2 down for cash and £1 2s. 6d. for three months, the backwardation narrowing to £3 10s. Zinc lost 5s. and 2s. 6d., while lead was 5s. down for May and unchanged forward. Tin closed £5 10s. down for cash and £7 10s. lower for forward.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* May 20, £239 10s. to £239 15s.; May 21, £240 to £240 10s.; May 24, £240 15s. to £241 5s.; May 25, £241 to £241 5s.; May 26, £240 15s. to £241.

Three Months: May 20, £236 to £236 5s.; May 21, £237 to £237 5s.; May 24, £237 15s. to £238; May 25, £237 15s. to £238; May 26, £237 15s. to £238.

TIN, Standard—*Cash:* May 20, £724 to £725; May 21, £726 to £727; May 24, £722 10s. to £725; May 25, £727 to £728; May 26, £725 to £727 10s.

Three Months: May 20, £724 to £725; May 21, £725 to £725 10s.; May 24, £721 to £722 10s.; May 25, £726 to £727; May 26, £725 to £726.

ZINC—*May:* May 20, £78 17s. 6d. to £79; May 21, £79 2s. 6d. to £79 5s.; May 24, £79 2s. 6d. to £79 5s.; May 25, £79 7s. 6d. to £79 10s.; May 26, £79 12s. 6d. to £79 15s.

August: May 20, £78 15s. to £79; May 21, £79 2s. 6d. to £79 5s.; May 24, £79 2s. 6d. to £79 7s. 6d.; May 25, £79 10s. to £79 12s. 6d.; May 26, £79 15s. to £79 17s. 6d.

LEAD—*May:* May 20, £94 10s. to £94 15s.; May 21, £94 15s. to £95; May 24, £94 15s. to £95 5s.; May 25, £94 17s. 6d. to £95; May 26, £95 5s. to £95 10s.

Second half August: May 20, £93 2s. 6d. to £93 5s.; May 21, £93 5s. to £93 10s.; May 24, £93 12s. 6d. to £93 15s.; May 25, £94 to £94 2s. 6d.; May 26, £94 10s. to £94 15s.

Bronze and Brass Founders' Advisory Service

The next meeting convened by the Association of Bronze and Brass Founders, under their advisory service scheme, will be held at the Victoria Hotel, Wolverhampton, on June 2, at 2.15 p.m. The purpose of the meeting will be to discuss actual foundry layouts, plans of which have been previously submitted.

Model Forms of Contract

A new model form of general conditions of contract known as "B3," "Export Contracts (including Delivery to and Erection on Site of Electrical and Mechanical Plant)," has been prepared by a joint committee of the Institution of Mechanical Engineers and the Institution of Electrical Engineers, and published under the authority of the councils of the two institutions. The new form supersedes the provisions of the existing form "B2," which dealt with this type of contract for electrical work. Form "B2," however, continues to be available for use in electrical export contracts involving supervision of erection only. Consideration is being given by the joint committee to the preparation of additional model forms of contract for export.